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# Development and Proof Services



REPORT NO. DPS/TW-201/3

INFANTRY AND AIRCRAFT WEAPONS DIVISION

REPORT ON

## FRAGMENTATION OF SHELL, HE, 115-MM, XM378 COMPOSITION B LOADED (U)

Third Report on Ordnance Project No. TW-201

(D. A. Project No. 517-07-021)

J. T. DEMPSEY

APRIL 1960



Aberdeen Proving Ground
Maryland

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DEVELOPMENT AND PROOF SERVICES
ABERDEEN PROVING GROUND
MARYLAND

AUTHORITY: ORDBB-TE3 470 JTDempsey/ma/41155

# FRAGMENTATION OF SHELL, HE, 115-MM, XM378

## COMPOSITION B LOADED (U)

Third Report on Ordnance Project No. TW-201

Dates of Test: November 1959 to March 1960

ABSTRACT (C)

The Feltman Research and Engineering Laboratories developed a pearlitic malleable iron shell, the XM378, 115-mm, Comp B loaded. This shell was developed to be used with the XM71 launcher system and is expected to be an improvement over present artillery shell.

Three Shell, HE, 115-mm, XM378 were fragmented to evaluate fragmentation characteristics. The test results indicate that the shell will produce 32,115 fragments, with an average fragment weight of 5.11 grains, and a mean initial velocity of 4279 feet per second. Forty-four per cent of the fragments were in the weight group 0 to 1 grain.

It is recommended that an effort be made to reduce the number of small (0 to 1 grain), fragments produced by this shell. Further development is recommended in order to achieve this purpose.

CONTENTS (U)



(The Annex is on file in the Technical Library, APG, for reference purposes. Copies of the Annex may be furnished to recipients of this report upon request.)

## 1. (C) INTRODUCTION

A requirement exists for a self-propelled artillery weapon system to provide direct support to infantry, airborne and armored divisions. As present weapons approach their optimum in development, it becomes necessary to develop a new weapon to obtain improvement in artillery tactics. The rocket offers a definite promise in supplying the required advantage needed by field artillery in providing direct support.

The 115-mm, XM378 shell which has been developed at Picatinny Arsenal to be used with the XM71 launcher system is expected to be an improvement over present artillery shell. The body of this shell is pearlitic malleable iron which weighs approximately 22 pounds.

## 2. (C) DESCRIPTION OF MATERIEL

The following materiel was used in this test:

Three Shell, 115-mm, XM378, Composition B loaded, Lot No. PA-E-29784. This shell had a two-piece body made of pearlitic malleable iron brazed together just forward of the rotating band. Both pieces weighed approximately 22 pounds. The shell was modified to the extent that the large stud on the base of the shell, as shown on drawing No. DXP-107800, Appendix A, was removed, and the base tapped for a brass plug which was screwed in flush with the base of the shell (see Correspondence, Appendix A). The composition B filler had an approximate weight of 10.4 pounds.

Three Fuzes, PD, M51A5, modified for static firing. No lot number.

Three blasting caps, electric, type II.

## 3. DETAILS OF TEST

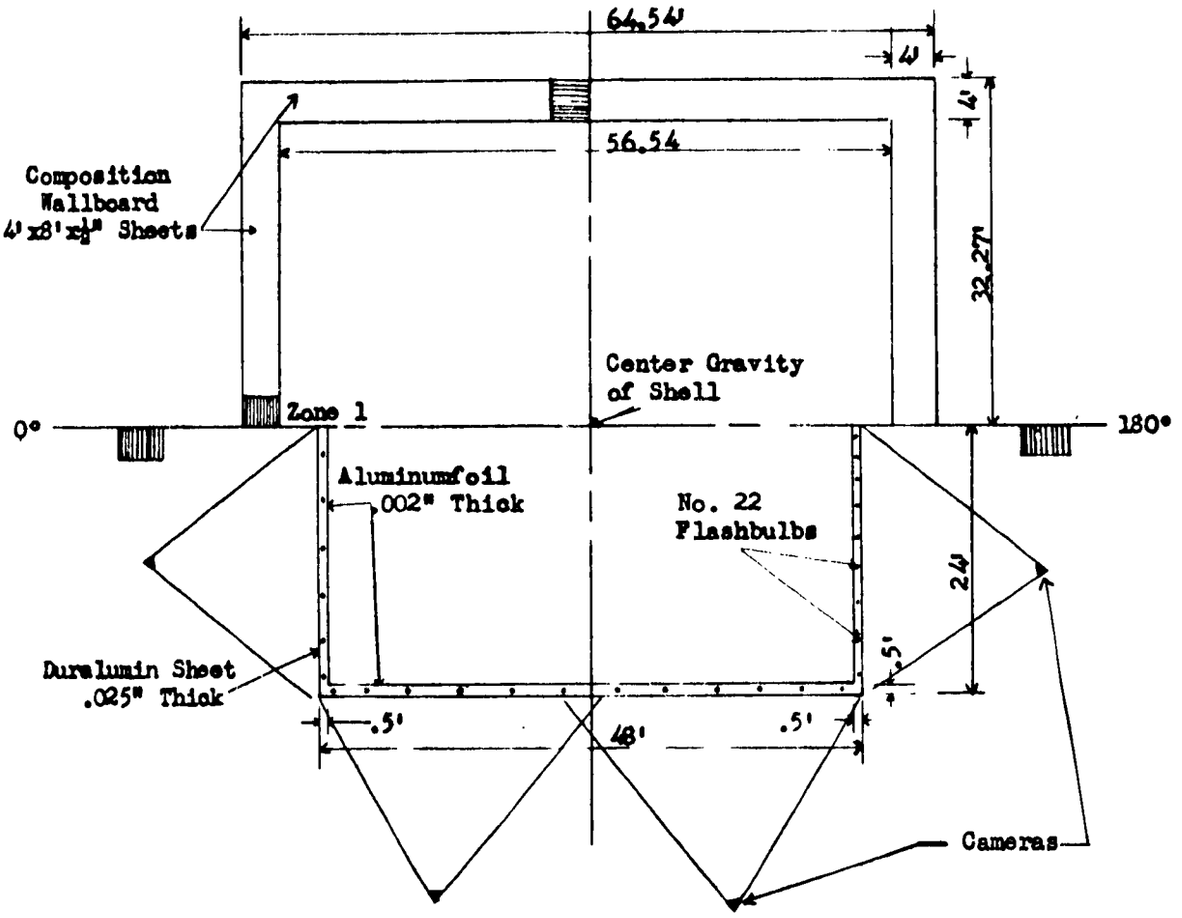
### 3.1 (U) Facilities

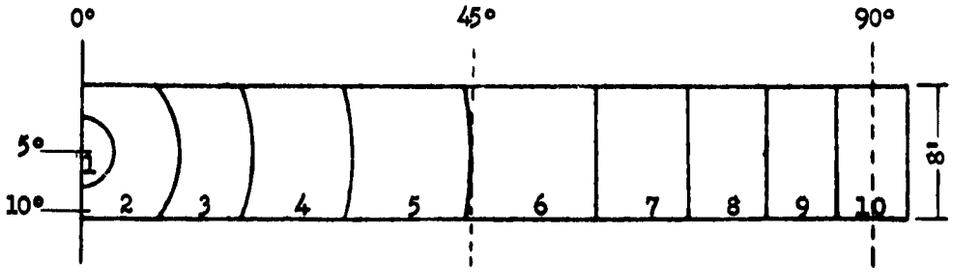
The facilities used for the fragmentation test consisted of a rectangular arena arranged around the ammunition. One half of the arena contained 180° of recovery surface and the other half 180° of velocity targets.

The fragment-recovery area consisted of a wooden structure which contained 4- by 8-foot by 1/2-inch sheets of composition wallboard placed upright to a depth of 4 feet. The wallboard was gridded into 10° zones, annular zones from 0° to 45° and 135° to 180°, vertical zones from 45° to 135° (zone 1, 0° to 5°; zone 2, 5° to 15°; zone 3, 15° to 25°; etc.). In addition, two boxes, 4 by 8 by 3 feet in depth, were filled with composition wallboard and placed outside of the test arena. One was placed at the nose end or 0°, and the other at the base end or 180°, both 35 feet from the center of the test setup. These recovery boxes were used to obtain additional information from both the nose and base fragments. This was accomplished by subtending the arc of both zone 1 on the nose box and zone 19 on the base box, which made it possible to recover a better sample of fragments that penetrated the wallboard in these two zones.

Figures 1, 2, and 3 show the plan view and pictures of the setup.

PLAN VIEW OF TEST SETUP




ZONING OF RECOVERY AND VELOCITY TARGETS

Figure 1.

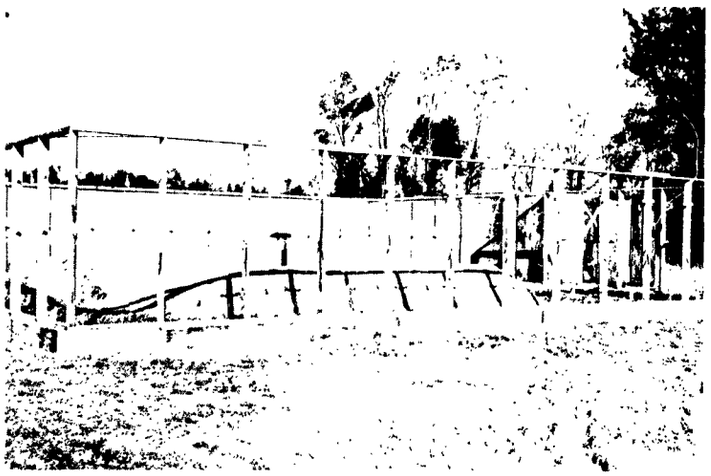


Figure 2 - 547382: General View of Test Setup.

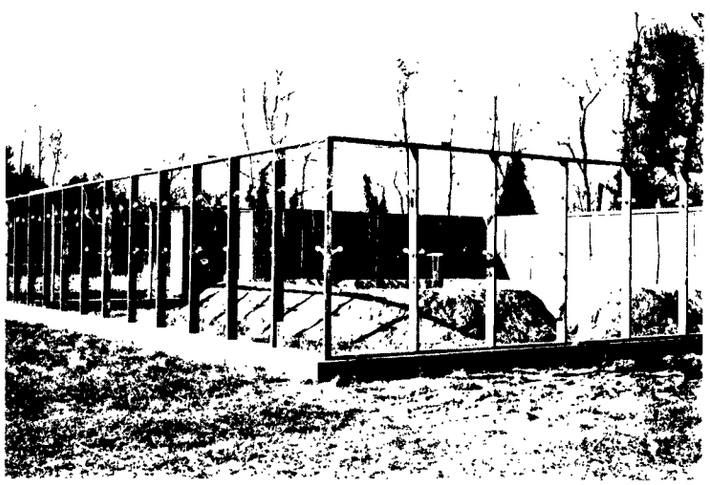


Figure 3 - 547382: General View of Test Setup Showing Zoning for Fragment Recovery.

The fragment-velocity setup consisted of two 180°, rectangular, vertical walls constructed 8 feet high, and set 6 inches apart with vertical supports every 4 feet. The outer wall contained 24 sheets of duralumin, each 4 by 8 feet by 0.025 inch thick with the outside surface painted black, and gridded into 2-foot horizontal sections and 19 zones vertically which corresponded with the zones gridded on the wallboard. Figures 4 and 5 show velocity-target gridding. The perpendicular distance from the center of the ammunition to the duralumin at 0°, 90°, and 180° was 24 feet. The inner wall was composed

of 0.002-inch aluminum foil which was used as a reflector for the number 22 flashbulbs placed at intervals between the walls (nine bulbs for each 4-foot by 9-foot target area). These bulbs were timed to be at their maximum brilliance when the fragments perforated the velocity targets. Flashbulbs were also placed around the outside of the arena, and positioned to illuminate the velocity targets so a record of the gridding would be visible on the high-speed film. The flashbulb function was synchronized by means of an electronic sequence timer which assured that the outside bulbs be out before the fragments struck the velocity targets.

Four high-speed motion-picture cameras operating at a speed of approximately 10,000 frames per second and equipped with frequency standards and electronic timing devices were positioned around the targets to photograph both the detonation of the shell and the impact of fragments on the velocity targets. To insure positive identification of detonation, the cameras were focused through a cylinder of 1/16-inch cardboard and 4 inches in diameter which was placed through holes cut in the duralumin foil. Views of the flashbulb reflectors and cardboard cylinders in position are shown in Figures 4 and 5.

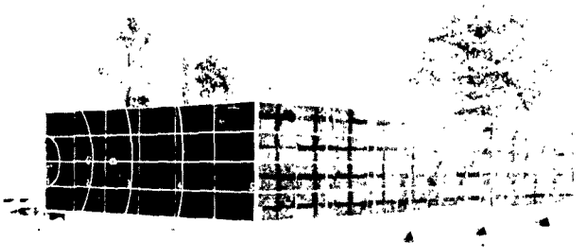


Figure 4 - 59T3823: General View of Velocity Targets Showing Gridding.

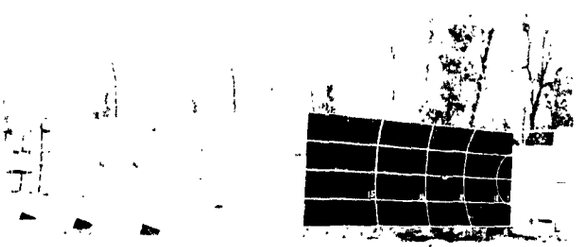


Figure 5 - 59T3827: General View of Velocity Targets Showing Gridding.

OPM 80-16, Volume IV, contains further details of flashbulb installation and velocity measurement technique.

A richochet stop was provided for both the recovery area and the velocity targets to prevent fragments that struck the ground from ricocheting into the recovery or velocity panels. OPM 70-90, Volume 7, contains other details on fragmentation procedure.

3.2 Procedure

(U) The shell and component parts were weighed and the recorded weights are shown in Table I.

Table I (C). Shell, 115-mm, XM378, Lot No. PA-E-29784

| Rd No. | Shell No. | Weight Empty, lb | Weight Explosive Comp B, lb | Weight Loaded, lb | Weight Fuze M51A1 Modified, lb | Weight As Fired, lb |
|---|---|---|---|---|---|---|
| 1 | 1 | 22.16 | 10.39 | 32.55 | 1.51 | 34.06 |
| 2 | 2 | 22.04 | 10.41 | 32.45 | 1.51 | 33.96 |
| 3 | 5 | 21.63 | 10.52 | 32.15 | 1.51 | 33.66 |

(U) Each shell was assembled with Fuze, PD, M51A5, modified for static firing, and placed individualy on a wooden pedestal at the center of the setup. The pedestal was constructed so that the horizontal centerline of the shell corresponded with the horizontal centerline of both the recovery boxes and velocity targets. The nose of each shell pointed toward the edges of the composition wallboard and velocity targets at zero degrees. The shell was detonated by using a blasting cap, electric, type II initiated by a 110-volt power source.

(U) After detonation of each shell, a plot of the position of each hit in the duralumin targets was recorded on graph paper. This was used to correlate with the image of hits obtained on the high-speed film. Then, knowing the distance from the shell to the target, and the fragment travel time (which is obtained from the high-speed film) the individual fragment velocity was computed.

(U) The fragments that impacted the wallboard were located by using an electronic metal detector. After being located the fragments were identified and recovered by zones, cleaned, weighed, and tabulated. The individual fragment weights are found in Appendix B.

(U) A sample of the recovered fragments, identified by zone and segregated into weight groups, is shown in Figures 6 and 7.

Tables II, III, and IV show the distribution of fragments by number and weight group.

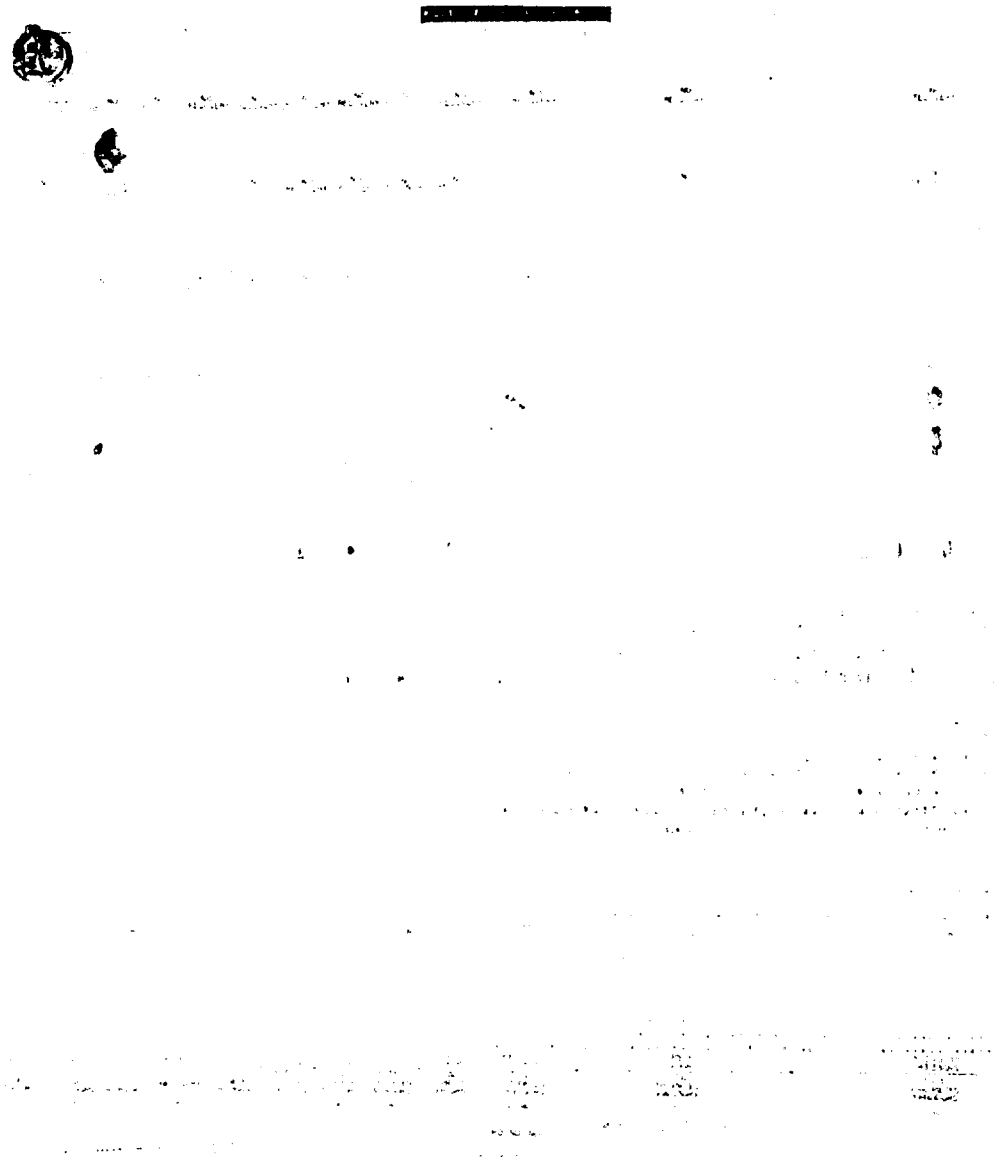


Figure 6 - 1315-81-2T59: Recovered Fragments of Shell, 115-mm, XM378 Composition B Loaded, Zones 1 to 11.

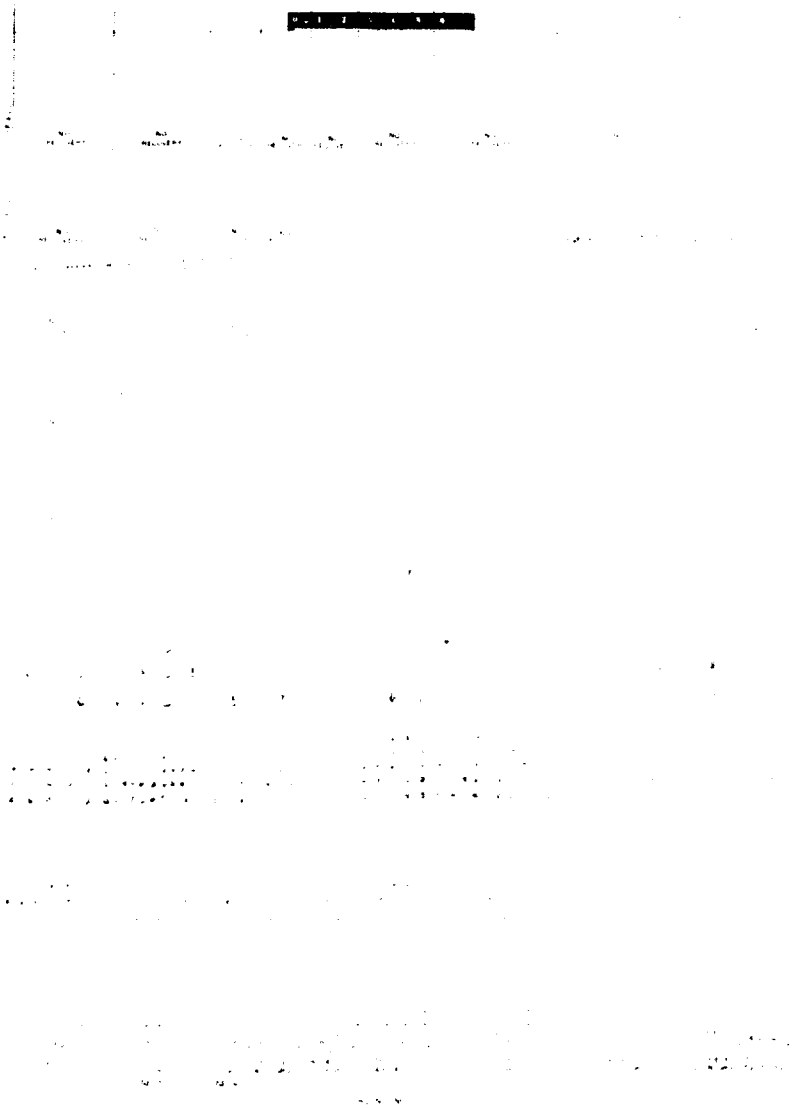


Figure 7 - 1315-81-1159: Recovered Fragments of Shell, 115-mm, XM378 Composition B Loaded, Zones 12 to 19.

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TABLE II (C)

## FRAGMENT RECOVERY

TYPE: 115-mm XM378 DATE FIRED: 4 November 1959 ROUND NO.: 1

FILLER: Composition B

| WEIGHT INTERVALS IN GRAIN | | DISTRIBUTION OF FRAGMENTS BY NUMBER AND WEIGHT | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ZONE 1 | ZONE 2 | ZONE 3 | ZONE 4 | ZONE 5 | ZONE 6 | ZONE 7 | ZONE 8 | ZONE 9 | ZONE 10 | ZONE 11 |
| 0-1 | NO. | 1 | 2 | N | | 2 | 4 | 3 | 17 | 49 | 152 | 306 |
| | WT. | 0.34 | 0.99 | O | | 0.69 | 2.32 | 1.30 | 3.29 | 16.09 | 56.20 | 85.35 |
| 1-2 | NO. | 3 | 1 | | | 2 | 1 | | 3 | 19 | 39 | 83 |
| | WT. | 4.45 | 1.84 | D | | 3.18 | 1.72 | | 5.00 | 27.88 | 59.01 | 118.62 |
| 2-5 | NO. | 3 | | E | | 3 | 3 | 4 | 5 | 19 | 63 | 113 |
| | WT. | 9.95 | | C | | 11.43 | 7.89 | 13.36 | 16.58 | 69.03 | 198.82 | 379.94 |
| 5-6 | NO. | 2 | | O | | 2 | | | 1 | 10 | 20 | 52 |
| | WT. | 11.30 | | V | | 5.35 | | | 5.00 | 65.30 | 124.94 | 330.05 |
| 8-10 | NO. | | | E | 1 | | | | | 3 | 17 | 25 |
| | WT. | | | R | 8.39 | | | | | 26.82 | 150.68 | 222.90 |
| 10-15 | NO. | 2 | | Y | | | 2 | | | 3 | 16 | 37 |
| | WT. | 26.27 | | | | | 22.20 | | | 37.36 | 199.53 | 457.05 |
| 15-20 | NO. | | | | | | | 1 | | | 4 | 25 |
| | WT. | | | | | | | 15.80 | | | 65.51 | 434.42 |
| 20-25 | NO. | | 2 | | | 1 | | | | 1 | 3 | 11 |
| | WT. | | 45.05 | | | 22.58 | | | | 20.70 | 61.64 | 249.72 |
| 25-35 | NO. | | | | | | | | | 1 | 1 | 15 |
| | WT. | | | | | | | | | 31.86 | 28.80 | 453.53 |
| 35-50 | NO. | | | | | | | | | | | 6 |
| | WT. | | | | | | | | | | | 246.40 |
| 50-60 | NO. | | | | | | | | | | | 5 |
| | WT. | | | | | | | | | | | 283.74 |
| 60-70 | NO. | | | | | | | | | | | 2 |
| | WT. | | | | | | | | | | | 130.08 |
| 70-80 | NO. | | | | | | | | | | | 1 |
| | WT. | | | | | | | | | | | 71.20 |
| 80-90 | NO. | | | | | 1 | | | | | | 1 |
| | WT. | | | | | 86.22 | | | | | | 88.80 |
| 90-100 | NO. | | | | | | 1 | | | | | 2 |
| | WT. | | | | | | 94.14 | | | | | 183.80 |



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## FRAGMENT RECOVERY

TYPE: 115-mm XM378 DATE FIRED: 4 November 1959 ROUND NO.: 1

FILLER: Composition B

| WEIGHT INTERVALS IN GRAIN | | DISTRIBUTION OF FRAGMENTS BY NUMBER AND WEIGHT | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ZONE 1 | ZONE 2 | ZONE 3 | ZONE 4 | ZONE 5 | ZONE 6 | ZONE 7 | ZONE 8 | ZONE 9 | ZONE 10 | ZONE 11 |
| 100-125 | NO. | 1 | | | | | | | | | | 2 |
| | WT. | 105.00 | | | | | | | | | | 213.00 |
| 125-150 | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| 150-200 | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| 200-250 | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| 250-300 | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| 300-400 | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| 400-500 | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| 500-750 | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| 750-1000 | NO. | 1 | | | | | | | | | | |
| | WT. | 945.00 | | | | | | | | | | |
| 1000 & Over | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| TOTAL | NO. | 13 | 5 | - | 1 | 10 | 11 | 8 | 26 | 105 | 315 | 686 |
| | WT. | 1102.39 | 47.88 | - | 8.39 | 129.65 | 130.17 | 30.46 | 29.87 | 289.09 | 956.23 | 3948.63 |



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## FRAGMENT RECOVERY

TYPE: 115-mm XM378 DATE FIRED: 4 November 1959 ROUND NO.: 1

FILLER: Composition B

| WEIGHT INTERVALS IN GRAIN | | DISTRIBUTION OF FRAGMENTS BY NUMBER AND WEIGHT | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ZONE 12 | ZONE 13 | ZONE 14 | ZONE 15 | ZONE 16 | ZONE 17 | ZONE 18 | ZONE 19 | | | TOTAL |
| 0-1 | NO. | 36 | 22 | 16 | 11 | 2 | 84 | 78 | 102 | | | 887 |
| | WT. | 12.97 | 8.06 | 3.75 | 6.86 | 0.80 | 25.93 | 24.38 | 22.35 | | | 271.87 |
| 1-2 | NO. | 12 | 10 | 2 | 2 | 1 | 23 | 44 | 6 | | | 251 |
| | WT. | 17.84 | 14.15 | 3.66 | 2.64 | 1.85 | 34.76 | 65.49 | 8.95 | | | 371.84 |
| 2-5 | NO. | 11 | 23 | 5 | 5 | 1 | 13 | 34 | 10 | | | 315 |
| | WT. | 36.84 | 67.88 | 16.50 | 16.62 | 3.44 | 37.76 | 105.05 | 31.11 | | | 1018.25 |
| 5-8 | NO. | 2 | 14 | 1 | | | 6 | 7 | 7 | | | 123 |
| | WT. | 10.82 | 91.39 | 6.67 | | | 33.15 | 43.17 | 43.02 | | | 780.27 |
| 8-10 | NO. | 2 | 3 | 1 | | | 4 | 5 | 2 | | | 63 |
| | WT. | 17.11 | 27.97 | 8.14 | | | 35.06 | 46.15 | 17.11 | | | 560.63 |
| 10-15 | NO. | 4 | 6 | | | | 4 | 6 | 1 | | | 81 |
| | WT. | 46.19 | 67.78 | | | | 44.91 | 72.52 | 12.50 | | | 986.21 |
| 15-20 | NO. | | 1 | | 1 | | 2 | 3 | 2 | | | 39 |
| | WT. | | 15.45 | | 19.05 | | 37.72 | 51.88 | 32.95 | | | 672.78 |
| 20-25 | NO. | | | | | | | 3 | | | | 21 |
| | WT. | | | | | | | 62.84 | | | | 462.53 |
| 25-35 | NO. | | 3 | 1 | | | | | 4 | | | 25 |
| | WT. | | 87.63 | 25.27 | | | | | 123.20 | | | 750.29 |
| 35-50 | NO. | | | | | | | | 2 | | | 8 |
| | WT. | | | | | | | | 84.02 | | | 330.42 |
| 50-60 | NO. | | | | | | | | | | | 5 |
| | WT. | | | | | | | | | | | 283.74 |
| 60-70 | NO. | | | | | | | | 1 | | | 3 |
| | WT. | | | | | | | | 63.80 | | | 193.88 |
| 70-80 | NO. | | | | | | | | 1 | | | 2 |
| | WT. | | | | | | | | 76.20 | | | 147.40 |
| 80-90 | NO. | | | | | | | | 1 | | | 3 |
| | WT. | | | | | | | | 83.06 | | | 258.08 |
| 90-100 | NO. | | | | | | | | 1 | | | 4 |
| | WT. | | | | | | | | 97.18 | | | 375.12 |



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## FRAGMENT RECOVERY

TYPE: 115-mm XM378 DATE FIRED: 4 November 1959 ROUND NO.: 1

FILLER: Composition B

| WEIGHT INTERVALS IN GRAIN | | DISTRIBUTION OF FRAGMENTS BY NUMBER AND WEIGHT | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ZONE 12 | ZONE 13 | ZONE 14 | ZONE 15 | ZONE 16 | ZONE 17 | ZONE 18 | ZONE 19 | | | TOTAL |
| 100-125 | NO. | | | | | | | | | | | 3 |
| | WT. | | | | | | | | | | | 318.00 |
| 125-150 | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| 150-200 | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| 200-250 | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| 250-300 | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| 300-400 | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| 400-500 | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| 500-750 | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| 750-1000 | NO. | | | | | | | | | | | 1 |
| | WT. | | | | | | | | | | | 945.00 |
| 1000 & Over | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| TOTAL | NO. | 67 | 82 | 26 | 19 | 4 | 136 | 180 | 140 | | | 1834 |
| | WT. | 141.77 | 380.31 | 63.99 | 45.17 | 6.09 | 249.29 | 471.48 | 695.45 | | | 8726.31 |



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## FRAGMENT RECOVERY

TYPE: 115-mm XM378 DATE FIRED: 4 November 1959 ROUND NO.: 1

FILLER: Composition B

| WEIGHT INTERVALS IN GRAIN | | DISTRIBUTION OF FRAGMENTS BY NUMBER AND WEIGHT | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ZONE 1N | ZONE 2N | TOTAL | | ZONE 19B | ZONE 18B | TOTAL | | | GRAND TOTAL ALL FRAGS |
| 0-1 | NO. | 1 | 1 | 2 | | 3 | 16 | 19 | | | 903 |
| | WT. | 0.75 | 0.99 | 1.74 | | 1.00 | 4.87 | 5.87 | | | 279.46 |
| 1-2 | NO. | 2 | | 2 | | 1 | 8 | 9 | | | 262 |
| | WT. | 2.78 | | 2.78 | | 1.50 | 12.43 | 13.93 | | | 386.55 |
| 2-5 | NO. | 7 | | 7 | | 1 | 5 | 6 | | | 328 |
| | WT. | 26.28 | | 26.28 | | 2.09 | 15.81 | 17.90 | | | 1062.43 |
| 5-8 | NO. | | | | | | 1 | 1 | | | 124 |
| | WT. | | | | | | 5.92 | 5.92 | | | 786.19 |
| 8-10 | NO. | | | | | | | | | | 63 |
| | WT. | | | | | | | | | | 560.63 |
| 10-15 | NO. | 2 | | 2 | | 2 | | 2 | | | 65 |
| | WT. | 26.64 | | 26.64 | | 21.59 | | 21.59 | | | 1034.44 |
| 15-20 | NO. | 1 | | 1 | | | | | | | 40 |
| | WT. | 18.16 | | 18.16 | | | | | | | 690.94 |
| 20-25 | NO. | | | | | | | | | | 21 |
| | WT. | | | | | | | | | | 462.53 |
| 25-35 | NO. | | | | | | | | | | 25 |
| | WT. | | | | | | | | | | 750.29 |
| 35-50 | NO. | | | | | | | | | | 8 |
| | WT. | | | | | | | | | | 330.42 |
| 50-60 | NO. | | | | | | | | | | 5 |
| | WT. | | | | | | | | | | 283.74 |
| 60-70 | NO. | | | | | | | | | | 3 |
| | WT. | | | | | | | | | | 193.88 |
| 70-80 | NO. | | | | | | | | | | 2 |
| | WT. | | | | | | | | | | 147.40 |
| 80-90 | NO. | | | | | | | | | | 3 |
| | WT. | | | | | | | | | | 258.08 |
| 90-100 | NO. | | | | | | | | | | 4 |
| | WT. | | | | | | | | | | 375.12 |

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## FRAGMENT RECOVERY

TYPE: 115-mm XM378 DATE FIRED: 4 November 1959 ROUND NO.: 1

FILLER: Composition B

| WEIGHT INTERVALS IN GRAIN | | DISTRIBUTION OF FRAGMENTS BY NUMBER AND WEIGHT | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ZONE 1N | ZONE 2N | TOTAL | | ZONE 19B | ZONE 18B | TOTAL | | | GRAND TOTAL ALL FRAGS | |
| 100-125 | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| 125-150 | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| 150-200 | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| 200-250 | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| 250-300 | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| 300-400 | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| 400-500 | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| 500-750 | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| 750-1000 | NO. | | | | | | | | | | 1 | |
| | WT. | | | | | | | | | | 945.00 | |
| 1000 & Over | NO. | | 1 | 1 | | | | | | | 1 | |
| | WT. | | 5507.00 | 5507.00 | | | | | | | 5507.00 | |
| | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| TOTAL | NO. | 13 | 2 | 15 | | 7 | 30 | 37 | | | 1886 | |
| | WT. | 74.61 | 5507.99 | 5582.60 | | 26.18 | 39.03 | 65.21 | | | 14374.12 | |



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Table III (C)

## FRAGMENT RECOVERY

**TYPE:** 115-mm XM378 **DATE FIRED:** 12 November 1959 **ROUND NO.:** 2

**FILLER:** Composition B

| WEIGHT INTERVALS IN GRAIN | | DISTRIBUTION OF FRAGMENTS BY NUMBER AND WEIGHT | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ZONE 1 | ZONE 2 | ZONE 3 | ZONE 4 | ZONE 5 | ZONE 6 | ZONE 7 | ZONE 8 | ZONE 9 | ZONE 10 | ZONE 11 |
| 0-1 | NO. | 27 | 17 | N | 4 | 9 | 6 | 13 | 17 | 41 | 78 | 159 |
| | WT. | 6.89 | 5.60 | o | 0.66 | 2.54 | 1.71 | 4.23 | 4.13 | 12.59 | 20.37 | 53.14 |
| 1-2 | NO. | 4 | 6 | | | 3 | | 2 | 6 | 17 | 30 | 53 |
| | WT. | 4.70 | 8.29 | R | | 4.42 | | 3.14 | 7.83 | 24.01 | 44.48 | 86.29 |
| 2-5 | NO. | 2 | 2 | e | | 1 | 3 | | 6 | 13 | 41 | 90 |
| | WT. | 9.71 | 5.15 | c | | 2.78 | 8.32 | | 18.95 | 48.95 | 133.94 | 295.62 |
| 5-8 | NO. | | 2 | o | | | | 2 | | 4 | 19 | 44 |
| | WT. | | 13.75 | v | | | | 11.50 | | 26.30 | 120.70 | 282.86 |
| 8-10 | NO. | | 1 | e | | | | 1 | | 2 | 12 | 25 |
| | WT. | | 8.09 | r | | | | 9.00 | | 19.10 | 103.53 | 225.22 |
| 10-15 | NO. | 3 | | y | | | 2 | | | 2 | 15 | 34 |
| | WT. | 35.13 | | | | | 24.29 | | | 25.98 | 191.67 | 419.04 |
| 15-20 | NO. | | 1 | | | | | | | 3 | 8 | 28 |
| | WT. | | 17.86 | | | | | | | 49.50 | 130.15 | 469.82 |
| 20-25 | NO. | 2 | 1 | | | | | | | | 4 | 12 |
| | WT. | 43.00 | 22.82 | | | | | | | | 88.36 | 277.24 |
| 25-35 | NO. | 1 | | | | | 1 | | | 1 | 5 | 16 |
| | WT. | 33.20 | | | | | 25.36 | | | 28.12 | 143.62 | 532.13 |
| 35-50 | NO. | | | | | | | | | | 2 | 10 |
| | WT. | | | | | | | | | | 77.66 | 399.86 |
| 50-60 | NO. | | 1 | | | | | | | | | 5 |
| | WT. | | 51.20 | | | | | | | | | 267.08 |
| 60-70 | NO. | | 1 | | | | | | | | | 3 |
| | WT. | | 68.20 | | | | | | | | | 191.66 |
| 70-80 | NO. | | | | | | | | | | | 3 |
| | WT. | | | | | | | | | | | 218.10 |
| 80-90 | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| 90-100 | NO. | | | | | | 1 | | | | | |
| | WT. | | | | | | 96.80 | | | | | |



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## FRAGMENT RECOVERY

**TYPE:** 115-mm XM378 **DATE FIRED:** 12 November 1959 **ROUND NO.:** 2

**FILLER:** Composition B

| WEIGHT INTERVALS IN GRAIN | | DISTRIBUTION OF FRAGMENTS BY NUMBER AND WEIGHT | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ZONE 1 | ZONE 2 | ZONE 3 | ZONE 4 | ZONE 5 | ZONE 6 | ZONE 7 | ZONE 8 | ZONE 9 | ZONE 10 | ZONE 11 |
| 100-125 | NO. | | 1 | | | | 1 | | | | | |
| | WT. | | 101.00 | | | | 111.00 | | | | | |
| 125-150 | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| 150-200 | NO. | 1 | 1 | | | 1 | | | | | | |
| | WT. | 180.00 | 169.00 | | | 176.00 | | | | | | |
| 200-250 | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| 250-300 | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| 300-400 | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| 400-500 | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| 500-750 | NO. | | 1 | | | | | | | | | |
| | WT. | | 703.00 | | | | | | | | | |
| 750-1000 | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| 1000 and Over | NO. | 1 | | | | | | | | | | |
| | WT. | 5185.00 | | | | | | | | | | |
| | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| Total | NO. | 41 | 35 | - | 4 | 14 | 14 | 18 | 29 | 83 | 214 | 489 |
| | WT. | 5497.63 | 1173.96 | - | 0.66 | 185.74 | 267.48 | 27.87 | 30.91 | 234.55 | 1062.98 | 3718.05 |

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## FRAGMENT RECOVERY

TYPE: 115-mm XM378 DATE FIRED: 12 November 1959 ROUND NO.: 2

FILLER: Composition B

| WEIGHT INTERVALS IN GRAIN | | DISTRIBUTION OF FRAGMENTS BY NUMBER AND WEIGHT | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ZONE 12 | ZONE 13 | ZONE 14 | ZONE 15 | ZONE 16 | ZONE 17 | ZONE 18 | ZONE 19 | | | TOTAL |
| 0-1 | NO. | 12 | 27 | 15 | 1 | 7 | 80 | 163 | 117 | | | 793 |
| | WT. | 6.93 | 11.28 | 6.99 | 0.72 | 3.88 | 28.96 | 52.25 | 32.32 | | | 263.69 |
| 1-2 | NO. | 6 | 13 | 3 | 7 | 2 | 19 | 35 | 22 | | | 233 |
| | WT. | 8.52 | 17.23 | 5.00 | 9.68 | 3.14 | 27.67 | 50.64 | 33.46 | | | 338.49 |
| 2-5 | NO. | 13 | 16 | 6 | 1 | 1 | 9 | 38 | 23 | | | 265 |
| | WT. | 37.48 | 53.74 | 22.37 | 3.90 | 4.89 | 29.39 | 112.30 | 70.60 | | | 658.09 |
| 5-8 | NO. | 6 | 10 | 2 | | 1 | 4 | 6 | 6 | | | 109 |
| | WT. | 36.34 | 64.13 | 15.04 | | 6.60 | 27.07 | 50.63 | 39.70 | | | 694.62 |
| 8-10 | NO. | 2 | 6 | | | 2 | 3 | 2 | 2 | | | 58 |
| | WT. | 18.32 | 51.69 | | | 17.69 | 27.40 | 17.38 | 17.42 | | | 514.84 |
| 10-15 | NO. | | 3 | 2 | | | 2 | 9 | 5 | | | 77 |
| | WT. | | 38.74 | 26.88 | | | 24.23 | 114.92 | 61.79 | | | 962.67 |
| 15-20 | NO. | | 3 | | | | 2 | 2 | 1 | | | 48 |
| | WT. | | 54.96 | | | | 36.45 | 35.65 | 15.80 | | | 810.19 |
| 20-25 | NO. | | | | | | 1 | 1 | | | | 21 |
| | WT. | | | | | | 24.93 | 23.00 | | | | 479.35 |
| 25-35 | NO. | | 2 | | | | 2 | | 2 | | | 32 |
| | WT. | | 63.32 | | | | 66.42 | | 54.08 | | | 946.25 |
| 35-50 | NO. | | | | | | | | 1 | | | 13 |
| | WT. | | | | | | | | 37.80 | | | 515.32 |
| 50-60 | NO. | | | | | | | | | | | 6 |
| | WT. | | | | | | | | | | | 318.28 |
| 60-70 | NO. | | | | | | | | | | | 4 |
| | WT. | | | | | | | | | | | 259.86 |
| 70-80 | NO. | | | | | | | | | | | 3 |
| | WT. | | | | | | | | | | | 218.10 |
| 80-90 | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| 90-100 | NO. | | | | | | | | | | | 1 |
| | WT. | | | | | | | | | | | 96.80 |



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## FRAGMENT RECOVERY

**TYPE:** 115-mm XM378 **DATE FIRED:** 12 November 1959 **ROUND NO.:** 2

**FILLER:** Composition B

| WEIGHT INTERVALS IN GRAIN | | DISTRIBUTION OF FRAGMENTS BY NUMBER AND WEIGHT | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ZONE 12 | ZONE 13 | ZONE 14 | ZONE 15 | ZONE 16 | ZONE 17 | ZONE 18 | ZONE 19 | | | TOTAL |
| 100-125 | NO. | | | | | | | | | | | 2 |
| | WT. | | | | | | | | | | | 212.00 |
| 125-150 | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| 150-200 | NO. | | | | | | | | | | | 3 |
| | WT. | | | | | | | | | | | 525.00 |
| 200-250 | NO. | | | | | | | | 1 | | | 1 |
| | WT. | | | | | | | | 249.00 | | | 249.00 |
| 250-300 | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| 300-400 | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| 400-500 | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| 500-750 | NO. | | | | | | | | | | | 1 |
| | WT. | | | | | | | | | | | 703.00 |
| 750-1000 | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| 1000 and Over | NO. | | | | | | | | | | | 1 |
| | WT. | | | | | | | | | | | 5185.00 |
| | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| Total | NO. | 39 | 80 | 26 | 9 | 13 | 122 | 259 | 180 | | | 1671 |
| | WT. | 107.59 | 355.09 | 76.28 | 14.30 | 36.20 | 292.52 | 456.77 | 611.97 | | | 14150.55 |

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## FRAGMENT RECOVERY

**TYPE:** 115-mm XM378 **DATE FIRED:** 12 November 1959 **ROUND NO.:** 2

**FILLER:** Composition B

| WEIGHT INTERVALS IN GRAIN | | DISTRIBUTION OF FRAGMENTS BY NUMBER AND WEIGHT | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ZONE 1N | ZONE 2N | TOTAL | | ZONE 19B | ZONE 18B | TOTAL | | | Grand Total All Frags. |
| 0-1 | NO. | | | | | 76 | 34 | 110 | | | 903 |
| | WT. | | | | | 14.79 | 10.90 | 25.69 | | | 289.33 |
| 1-2 | NO. | 2 | | 2 | | 9 | 9 | 18 | | | 253 |
| | WT. | 2.85 | | 2.85 | | 12.16 | 12.67 | 24.83 | | | 366.17 |
| 2-5 | NO. | | | | | 11 | 9 | 20 | | | 265 |
| | WT. | | | | | 33.62 | 26.78 | 60.40 | | | 918.49 |
| 5-8 | NO. | 1 | 1 | 2 | | 1 | 2 | 3 | | | 114 |
| | WT. | 5.24 | 6.95 | 12.19 | | 6.27 | 12.49 | 18.76 | | | 725.57 |
| 8-10 | NO. | | | | | 1 | | 1 | | | 59 |
| | WT. | | | | | 8.55 | | 8.55 | | | 523.39 |
| 10-15 | NO. | 1 | | 1 | | | | | | | 78 |
| | WT. | 11.79 | | 11.79 | | | | | | | 974.46 |
| 15-20 | NO. | | 1 | 1 | | 1 | | 1 | | | 50 |
| | WT. | | 19.72 | 19.72 | | 17.73 | | 17.73 | | | 947.64 |
| 20-25 | NO. | | | | | | | | | | 21 |
| | WT. | | | | | | | | | | 479.35 |
| 25-35 | NO. | | | | | 1 | | 1 | | | 33 |
| | WT. | | | | | 28.77 | | 28.77 | | | 975.02 |
| 35-50 | NO. | | | | | | | | | | 13 |
| | WT. | | | | | | | | | | 515.32 |
| 50-60 | NO. | | | | | | | | | | 6 |
| | WT. | | | | | | | | | | 318.28 |
| 60-70 | NO. | | | | | | | | | | 4 |
| | WT. | | | | | | | | | | 259.66 |
| 70-80 | NO. | | | | | | | | | | 3 |
| | WT. | | | | | | | | | | 216.10 |
| 80-90 | NO. | | | | | | | | | | |
| | WT. | | | | | | | | | | |
| 90-100 | NO. | 1 | | 1 | | | | | | | 2 |
| | WT. | 93.42 | | 93.42 | | | | | | | 190.22 |



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## FRAGMENT RECOVERY

TYPE: 115-mm XM378 DATE FIRED: 12 November 1959 ROUND NO.: 2

FILLER: Composition B

| WEIGHT INTERVALS IN GRAIN | | DISTRIBUTION OF FRAGMENTS BY NUMBER AND WEIGHT | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ZONE 1N | ZONE 2N | TOTAL | | ZONE 19B | ZONE 18B | TOTAL | | | Grand Total All Frags. |
| 100-125 | NO. | | 1 | 1 | | | | | | | 3 |
| | WT. | | 116.00 | 116.00 | | | | | | | 330.00 |
| 125-150 | NO. | | | | | | | | | | |
| | WT. | | | | | | | | | | |
| 150-200 | NO. | | | | | | | | | | 3 |
| | WT. | | | | | | | | | | 525.00 |
| 200-250 | NO. | | | | | | | | | | 1 |
| | WT. | | | | | | | | | | 249.00 |
| 250-300 | NO. | | | | | | | | | | |
| | WT. | | | | | | | | | | |
| 300-400 | NO. | | | | | | | | | | |
| | WT. | | | | | | | | | | |
| 400-500 | NO. | | | | | | | | | | |
| | WT. | | | | | | | | | | |
| 500-750 | NO. | | | | | | | | | | 1 |
| | WT. | | | | | | | | | | 703.00 |
| 750-1000 | NO. | | | | | | | | | | |
| | WT. | | | | | | | | | | |
| 1000 and Over | NO. | | | | | | | | | | 1 |
| | WT. | | | | | | | | | | 3165.00 |
| | NO. | | | | | | | | | | |
| | WT. | | | | | | | | | | |
| | NO. | | | | | | | | | | |
| | WT. | | | | | | | | | | |
| | NO. | | | | | | | | | | |
| | WT. | | | | | | | | | | |
| | NO. | | | | | | | | | | |
| | WT. | | | | | | | | | | |
| Total | NO. | 5 | 3 | 8 | | 100 | 54 | 154 | | | 1833 |
| | WT. | 113.30 | 144.67 | 257.97 | | 121.69 | 62.84 | 184.73 | | | 14593.25 |

Table IV (C)

## FRAGMENT RECOVERY

**TYPE:** 115-mm XM378 **DATE FIRED:** 20 November 1959 **ROUND NO.:** 3

**FILLER:** Composition B

| WEIGHT INTERVALS IN GRAIN | | DISTRIBUTION OF FRAGMENTS BY NUMBER AND WEIGHT | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ZONE 1 | ZONE 2 | ZONE 3 | ZONE 4 | ZONE 5 | ZONE 6 | ZONE 7 | ZONE 8 | ZONE 9 | ZONE 10 | ZONE 11 |
| 0-1 | NO. | 9 | | | M | 2 | 3 | 3 | 20 | 48 | 154 | 277 |
| | WT. | 2.19 | | | o | 1.32 | 1.30 | 1.39 | 9.01 | 19.07 | 54.19 | 87.56 |
| 1-2 | NO. | 2 | | | | | | 2 | 7 | 6 | 46 | 77 |
| | WT. | 6.90 | | | R | | | 3.49 | 11.22 | 8.44 | 66.31 | 112.83 |
| 2-5 | NO. | 4 | 2 | 1 | e | 2 | 1 | | 4 | 21 | 59 | 121 |
| | WT. | 15.19 | 5.56 | 4.85 | c | 4.52 | 2.53 | | 14.51 | 65.78 | 191.78 | 403.33 |
| 5-8 | NO. | 1 | | | o | | 1 | | | 10 | 22 | 61 |
| | WT. | 5.42 | | | r | | 5.18 | | | 60.93 | 141.11 | 374.56 |
| 8-10 | NO. | | 1 | | e | | | | | 2 | 9 | 18 |
| | WT. | | 8.70 | | r | | | | | 19.78 | 78.74 | 163.27 |
| 10-15 | NO. | | | | y | | 1 | | | 3 | 14 | 41 |
| | WT. | | | | | | 10.80 | | | 36.06 | 176.15 | 487.52 |
| 15-20 | NO. | | 1 | | | | | | | 2 | 7 | 24 |
| | WT. | | 15.90 | | | | | | | 36.48 | 117.87 | 411.08 |
| 20-25 | NO. | 1 | 1 | | | | | | 1 | | 2 | 12 |
| | WT. | 24.72 | 21.45 | | | | | | 24.16 | | 42.76 | 269.96 |
| 25-35 | NO. | | 1 | | | | | | | | | 16 |
| | WT. | | 25.76 | | | | | | | | | 455.54 |
| 35-50 | NO. | | | 1 | | | | | | | | 9 |
| | WT. | | | 38.32 | | | | | | | | 378.04 |
| 50-60 | NO. | | | 1 | | | | | | | | 7 |
| | WT. | | | 54.50 | | | | | | | | 387.40 |
| 60-70 | NO. | | | | | | | | | | | 1 |
| | WT. | | | | | | | | | | | 61.88 |
| 70-80 | NO. | | | | | | | | | | | 2 |
| | WT. | | | | | | | | | | | 148.40 |
| 80-90 | NO. | | | | | | | | | | | 2 |
| | WT. | | | | | | | | | | | 171.24 |
| 90-100 | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |



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## FRAGMENT RECOVERY

**TYPE:** 115-mm XM378 **DATE FIRED:** 20 November 1959 **ROUND NO.:** 3

**FILLER:** Composition B

| WEIGHT INTERVALS IN GRAIN | | DISTRIBUTION OF FRAGMENTS BY NUMBER AND WEIGHT | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ZONE 1 | ZONE 2 | ZONE 3 | ZONE 4 | ZONE 5 | ZONE 6 | ZONE 7 | ZONE 8 | ZONE 9 | ZONE 10 | ZONE 11 |
| 100-125 | NO. | | 1 | | | | | | | | | |
| | WT. | | 103.00 | | | | | | | | | |
| 125-150 | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| 150-200 | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| 200-250 | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| 250-300 | NO. | | 1 | | | | | | | | | |
| | WT. | | 267.00 | | | | | | | | | |
| 300-400 | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| 400-500 | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| 500-750 | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| 750-1000 | NO. | | 1 | | | | | | | | | |
| | WT. | | 835.00 | | | | | | | | | |
| 1000 and Over | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| Total | NO. | 20 | 9 | 3 | - | 4 | 6 | 5 | 32 | 92 | 313 | 668 |
| | WT. | 54.42 | 1282.37 | 97.67 | - | 5.84 | 19.81 | 4.85 | 58.90 | 248.54 | 869.21 | 3912.61 |



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## FRAGMENT RECOVERY

**TYPE:** 115-mm XM378 **DATE FIRED:** 20 November 1959 **ROUND NO.:** 3

**FILLER:** Composition B

| WEIGHT INTERVALS IN GRAIN | | DISTRIBUTION OF FRAGMENTS BY NUMBER AND WEIGHT | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ZONE 12 | ZONE 13 | ZONE 14 | ZONE 15 | ZONE 16 | ZONE 17 | ZONE 18 | ZONE 19 | | | TOTAL |
| 0-1 | NO. | 19 | 22 | 21 | 6 | 7 | 55 | 60 | 76 | | | 782 |
| | WT. | 8.16 | 8.96 | 11.06 | 3.07 | 1.94 | 24.27 | 2[illegible].80 | 23.10 | | | 281.39 |
| 1-2 | NO. | 4 | 16 | 6 | | 1 | 21 | 36 | 22 | | | 249 |
| | WT. | 5.49 | 23.76 | 8.30 | | 1.39 | 27.93 | 49.61 | 32.03 | | | 358.20 |
| 2-5 | NO. | 7 | 22 | 8 | 4 | 2 | 15 | 29 | 31 | | | 535 |
| | WT. | 19.98 | 69.71 | 25.46 | 11.70 | 5.52 | 47.05 | 84.21 | 96.99 | | | 1060.97 |
| 5-8 | NO. | 1 | 10 | 1 | 1 | | 11 | 11 | 12 | | | 1.2 |
| | WT. | 7.42 | 61.41 | 6.22 | 7.36 | | 70.34 | 67.52 | 72.96 | | | 880.43 |
| 8-10 | NO. | | 6 | 1 | | 1 | | 8 | 2 | | | 4[illegible] |
| | WT. | | 57.38 | 9.50 | | 8.94 | | 72.71 | 16.44 | | | 435.46 |
| 10-15 | NO. | 4 | 3 | 1 | | | 3 | 9 | 2 | | | 81 |
| | WT. | 45.90 | 37.15 | 11.75 | | | 39.14 | 100.64 | 26.77 | | | 982.18 |
| 15-20 | NO. | | 4 | | | | | 2 | 1 | | | 41 |
| | WT. | | 69.42 | | | | | 35.83 | 17.48 | | | 704.06 |
| 20-25 | NO. | | 1 | | | | 1 | | 1 | | | 20 |
| | WT. | | 21.60 | | | | 24.72 | | 22.35 | | | 451.72 |
| 25-35 | NO. | | 2 | | | | | | | | | 19 |
| | WT. | | 52.51 | | | | | | | | | 533.81 |
| 35-50 | NO. | | | | | | | 3 | 1 | | | 14 |
| | WT. | | | | | | | 131.60 | 41.40 | | | 569.44 |
| 50-60 | NO. | | | | | | | | | | | 8 |
| | WT. | | | | | | | | | | | 441.90 |
| 60-70 | NO. | | | | | | | | | | | 1 |
| | WT. | | | | | | | | | | | 61.88 |
| 70-80 | NO. | | | | | | | | | | | 2 |
| | WT. | | | | | | | | | | | 148.40 |
| 80-90 | NO. | | | | | | | | | | | 2 |
| | WT. | | | | | | | | | | | 171.24 |
| 90-100 | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |

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## FRAGMENT RECOVERY

**TYPE:** 115-mm XM378 **DATE FIRED:** 20 November 1959 **ROUND NO.:** 3

**FILLER:** Composition B

| WEIGHT INTERVALS IN GRAIN | | DISTRIBUTION OF FRAGMENTS BY NUMBER AND WEIGHT | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ZONE 12 | ZONE 13 | ZONE 14 | ZONE 15 | ZONE 16 | ZONE 17 | ZONE 18 | ZONE 19 | | | TOTAL |
| 100-125 | NO. | | | | | | | | | | | 1 |
| | WT. | | | | | | | | | | | 103.00 |
| 125-150 | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| 150-200 | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| 200-250 | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| 250-300 | NO. | | | | | | | | | | | 1 |
| | WT. | | | | | | | | | | | 267.00 |
| 300-400 | NO. | | | | | | | | 1 | | | 1 |
| | WT. | | | | | | | | 306.00 | | | 306.00 |
| 400-500 | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| 500-750 | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| 750-1000 | NO. | | | | | | | | | | | 1 |
| | WT. | | | | | | | | | | | 835.00 |
| 1000 and Over | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| Total | NO. | 35 | 86 | 38 | 11 | 11 | 106 | 158 | 149 | | | 1746 |
| | WT. | 86.95 | 501.90 | 72.79 | 22.13 | 17.79 | 233.15 | 575.30 | 655.52 | | | 8620.08 |



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## FRAGMENT RECOVERY

**TYPE:** 11[illegible]-mm XM378 **DATE FIRED:** 20 November 1959 **ROUND NO.:** 3

**FILLER:** Composition B

| WEIGHT INTERVALS IN GRAIN | | DISTRIBUTION OF FRAGMENTS BY NUMBER AND WEIGHT | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ZONE 1 N | ZONE 2N | TOTAL | ZONE 19B | ZONE 18B | TOTAL | | | | Grand Total All Frags. | |
| 0-1 | NO. | 8 | 3 | 11 | 25 | 14 | 39 | | | | 832 | |
| | WT. | 3.72 | 1.44 | 5.16 | 10.09 | 6.92 | 17.00 | | | | 303.55 | |
| 1-2 | NO. | 4 | | 4 | 5 | 7 | 12 | | | | 265 | |
| | WT. | 5.16 | | 5.16 | 6.41 | 9.66 | 16.09 | | | | 379.47 | |
| 2-5 | NO. | 1 | 1 | 2 | 6 | 4 | 10 | | | | 345 | |
| | WT. | 2.09 | 4.70 | 6.79 | 21.35 | 12.54 | 33.89 | | | | 1109.65 | |
| 5-8 | NO. | | 1 | 1 | 3 | 2 | 5 | | | | 146 | |
| | WT. | | 5.73 | 5.73 | 19.68 | 10.96 | 30.64 | | | | 916.80 | |
| 8-10 | NO. | | | | 3 | | 3 | | | | 51 | |
| | WT. | | | | 27.01 | | 27.01 | | | | 462.47 | |
| 10-15 | NO. | 1 | 1 | 2 | | | | | | | 83 | |
| | WT. | 10.13 | 10.13 | 20.26 | | | | | | | 1002.44 | |
| 15-20 | NO. | 1 | | 1 | 1 | | 1 | | | | 43 | |
| | WT. | 15.07 | | 15.07 | 18.72 | | 18.72 | | | | 737.85 | |
| 20-25 | NO. | 2 | | 2 | | | | | | | 22 | |
| | WT. | 45.64 | | 45.64 | | | | | | | 497.56 | |
| 25-35 | NO. | | | | | | | | | | 19 | |
| | WT. | | | | | | | | | | 533.81 | |
| 35-50 | NO. | | | | | | | | | | 14 | |
| | WT. | | | | | | | | | | 569.44 | |
| 50-60 | NO. | | | | | | | | | | 8 | |
| | WT. | | | | | | | | | | 441.90 | |
| 60-70 | NO. | | 1 | 1 | | | | | | | 2 | |
| | WT. | | 62.82 | 62.82 | | | | | | | 124.70 | |
| 70-80 | NO. | | | | | | | | | | 2 | |
| | WT. | | | | | | | | | | 148.40 | |
| 80-90 | NO. | | | | | | | | | | 2 | |
| | WT. | | | | | | | | | | 171.24 | |
| 90-100 | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |



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## FRAGMENT RECOVERY

**TYPE:** 115-mm XM378 **DATE FIRED:** 20 November 1959 **ROUND NO.:** 3

**FILLER:** Composition B

| WEIGHT INTERVALS IN GRAIN | | DISTRIBUTION OF FRAGMENTS BY NUMBER AND WEIGHT | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ZONE 1N | ZONE 2N | TOTAL | ZONE 19B | ZONE 18B | TOTAL | | | | Grand Total All Frags. | |
| 100-125 | NO. | | | | | | | | | | 1 | |
| | WT. | | | | | | | | | | 103.00 | |
| 125-150 | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| 150-200 | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| 200-250 | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| 250-300 | NO. | | | | | | | | | | 1 | |
| | WT. | | | | | | | | | | 267.00 | |
| 300-400 | NO. | | | | | | | | | | 1 | |
| | WT. | | | | | | | | | | 306.00 | |
| 400-500 | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| 500-750 | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| 750-1000 | NO. | | | | | | | | | | 1 | |
| | WT. | | | | | | | | | | 835.00 | |
| 1000 and Over | NO. | 1 | | 1 | | | | | | | 1 | |
| | WT. | 5761.00 | | 5761.00 | | | | | | | 5761.00 | |
| | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| | NO. | | | | | | | | | | | |
| | WT. | | | | | | | | | | | |
| Total | NO. | 18 | 7 | 25 | 43 | 27 | 70 | | | | 1841 | |
| | WT. | 5843.03 | 84.82 | 5927.85 | 103.25 | 40.10 | 143.35 | | | | 14691.28 | |



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3.3 Analysis of Data

(U) The initial velocity ($V_o$) of the fragments was obtained by using the following equation:

$$V_o = V_p \quad \frac{e^{\frac{ar}{m_r 1/3}} - 1}{\frac{ar}{m_r 1/3}} \qquad \text{where}$$

$V_p$ = photographic velocity, fps.

r = distance from shell to target, feet.

$m_r$ = the representative fragment weight, grains.

a = 12 $K_{dP}$ k -2/3; where K is the fragment shape factor, $_P$ is the air density in grains/inch$^3$, and $K_d$ is the representative fragment drag coefficient. For a more complete and detailed definition see Appendix C.

The initial fragment velocities for each 10° increment are shown in Table V.

Table V (C). Average Fragment Velocity and Density, Rounds 1, 2, and 3

| Zone | Degree | Initial Velocity, fps | Density Fragments/Steradian |
|---|---|---|---|
| 1 | 0 | 2100 | 1707 |
| 2 | 10 | 1950 | 392 |
| 3 | 20 | [a]2550 | 24 |
| 4 | 30 | [a]3200 | 42 |
| 5 | 40 | 3800 | 265 |
| 6 | 50 | 3000 | 300 |
| 7 | 60 | 4900 | 267 |
| 8 | 70 | 5550 | 694 |
| 9 | 80 | 6200 | 2124 |
| 10 | 90 | 7300 | 6300 |
| 11 | 100 | 6300 | 13,999 |
| 12 | 110 | 7200 | 1112 |
| 13 | 120 | 4500 | 2140 |
| 14 | 130 | 3150 | 900 |
| 15 | 140 | 4100 | 369 |
| 16 | 150 | 3300 | 239 |
| 17 | 160 | 3250 | 2780 |
| 18 | 170 | 4350 | 4513 |
| 19 | 180 | 4600 | 9594 |

[a] Interpolated value.

(U) Table VI presents the number and weight of fragments recovered and the integrated data scaled to 100 per cent recovery for each round.

Table VI (C). Actual and Integrated Recovery

Actual Recovery

| Round No. | Total Weight, gr | Total Number of Fragments[a] | Average Fragment Weight, gr | As Fired Metal Parts Weight, lb |
|---|---|---|---|---|
| 1 | 14,374.12 | 1886 | 7.62 | 23.67 |
| 2 | 14,593.25 | 1833 | 7.96 | 23.55 |
| 3 | 14,691.28 | 1841 | 7.98 | 23.14 |
| Average | 14,552.88 | 1853 | 7.85 | 23.45 |

[a]Including fragment recovery from the extra nose and base boxes placed at 35 feet.

Integrated Recovery

| Round No. | Weight, lb | Number of Fragments | Average Fragment Weight, gr | Per Cent Recovery | Scaled Number of Fragments |
|---|---|---|---|---|---|
| 1 | 22.26 | 31,836 | 4.90 | 94.1 | 33,841 |
| 2 | 21.17 | 24,903 | 5.95 | 89.9 | 27,717 |
| 3 | 20.18 | 30,328 | 4.66 | 87.2 | 34,787 |
| Average | 21.20 | 29,022 | 5.11 | 90.4 | 32,115 |

(U) The total number of fragments produced was determined by the following equation:

$$N = 2\pi \int_0^{\pi} \sigma(\theta) \sin\theta \, d\theta$$

where $(\sigma)$ = Scaled number of fragments per unit solid angle (Steradian).
$\theta$ = Angle from axis of shell as measured from the nose.

See Table V for fragment density.

(C) The data in the above table shows approximately 20 per cent fewer fragments for round 2 than for the average of the other two rounds. A further separation was made to more clearly define the differences in the scaled number of fragments for the three rounds.

(U) Table VII presents the total number of scaled fragments per angular interval.

Table VII (C). Total Scaled Fragments per Angular Interval

| Round No. | 0° to 75° | 75° to 115° | 115° to 180° |
|---|---|---|---|
| 1 | 1315 | 27,691 | 4836 |
| 2 | 2008 | 20,392 | 5317 |
| 3 | 1296 | 28,224 | 5266 |

(C) As shown in Table VII, approximately 79 per cent of the fragments were in an angular interval extending from 75° to 115°. A difference of approximately 8000 fragments is shown between round 2 and the average of rounds 1 and 3 for this same angular interval. Since 44 per cent of the total fragments were in the smallest weight interval (0 to 1 grain), a tabulation of the number of fragments excluding the fragments in this weight interval is given in Table VIII below.

Table VIII (C). Number of Fragments per Angular Interval (Excluding Fragments Weighing Less than One Grain)

| Round No. | 0° to 75° | 75° to 115° | 115° to 180° | Total, 0° to 180° |
|---|---|---|---|---|
| 1 | 700 | 14,873 | 2631 | 18,204 |
| 2 | 801 | 13,224 | 2676 | 16,701 |
| 3 | 564 | 15,539 | 3117 | 19,220 |

(C) From these data it is apparent that most of the difference occurred in the number of fragments weighing less than one grain. However, it is indicated that round 2 produced slightly heavier fragments.

## 4. (C) CONCLUSIONS

It is concluded that:

a. Shell, 115-mm, XM378, Composition B loaded, will produce an average of 32,115 fragments weighing 5.11 grains, and having a mean initial velocity of 4279 feet per second.

b. Forty-four per cent of the total number of scaled fragments were in the weight interval of 0 to 1 grain.

c. Seventy-nine per cent of the fragments were found to be from the 75° to 115° angular section of the shell.

d. A lethality study is being conducted and will be reported under separate cover.

5. (C) RECOMMENDATIONS

Further investigation should be conducted regarding the use of different tensile strength pearlitic malleable iron shell casings for the development of a shell that will reduce the number of small fragments (0 to 1 grain) produced by the XM378 shell.

SUBMITTED:

J. T. Dempsey

J. T. DEMPSEY
Ordnance Technician

REVIEWED:

V. L. Grafton

V. L. GRAFTON
Chief, Terminal Effects
and Special Projects Branch

Claude E. Brown

C. E. BROWN
Chief, Infantry and
Aircraft Weapons Division

APPROVED:

H. A. Noble

H. A. NOBLE
Assistant Deputy Director
for Engineering Testing
Development and Proof Services

## APPENDICES

# CONFIDENTIAL

APPENDIX A
Correspondence

ORDNANCE CORPS
PICATINNY ARSENAL
DOVER, NEW JERSEY

Mr. J. V. Sagarese/sjg/2251

IN REPLY
REFER TO:
FELTMAN RESEARCH AND ENGINEERING LABORATORIES
ORDBB-TE3 470

AUG 25 '59 -3 PM

SUBJECT: Shell, HE, 115 mm XM378 (Project No. TW-201) (U)

TO: Commanding General
Aberdeen Proving Ground
Maryland
ATTENTION: ORDBG-DP-TI (Mr. M. Raabe)

1. (C) It is requested that complete fragmentation data be obtained from three of the five 115 mm XM378 HE Shell furnished. The desired data should include fragment velocity, fragment mass and spatial distribution. The data thus obtained will be used to determine lethality of subject shell. Fragment velocity is expected to be in the order of 5455 f/s.

2. (U) It is desired that the Analytical Laboratory oversee the test procedure and set-up. Further, it is desired that the Analytical Laboratory reduce the data and put the information in a form acceptable to the Weapons Systems Laboratory of Ballistic Research Laboratories.

3. (U) The Weapons Systems Laboratory of Ballistic Research Laboratories is requested to calculate the lethality of subject shell based upon the fragmentation data furnished.

4. (U) The shell metal parts weights have been taken and are furnished herewith:

| | |
|---|---|
| Shell No. 1 | 22.16 lbs. |
| Shell No. 2 | 22.04 lbs. |
| Shell No. 3 | 22.22 lbs. |
| Shell No. 4 | 21.35 lbs. |
| Shell No. 5 | 21.63 lbs. |

5. (U) The loaded shell weights have been taken and are furnished herewith:

| | |
|---|---|
| Shell No. 1 | 32.55 lbs. |
| Shell No. 2 | 32.45 lbs. |
| Shell No. 3 | 32.62 lbs. |
| Shell No. 4 | 31.91 lbs. |
| Shell No. 5 | 32.15 lbs. |

The above shell are to be fired in the order of 1, 2, 5, 3 and 4.

Ag Compl.
EC-21-59



7597

# CONFIDENTIAL

MWC CO 5-9-3601

ORDBB-TE3 470
SUBJECT: Shell, HE, 115 mm XM378 (Project No. TW-201) (U)

6. (U) Drawings Nos. DXP-106156 and -107800 delineating shell metal parts and loading assembly, respectively, are inclosed. Although a large stud is shown on Drawing No. DXP-106156, this stud has been removed. On Drawing No. DXP-107800, inert filler is indicated which has been replaced with H. E. (Comp B) filler.

7. (U) The priority of this work is 1A; an early test is requested. It is desired that notification of this test be furnished at least three days in advance of the test to permit attendance by interested personnel.

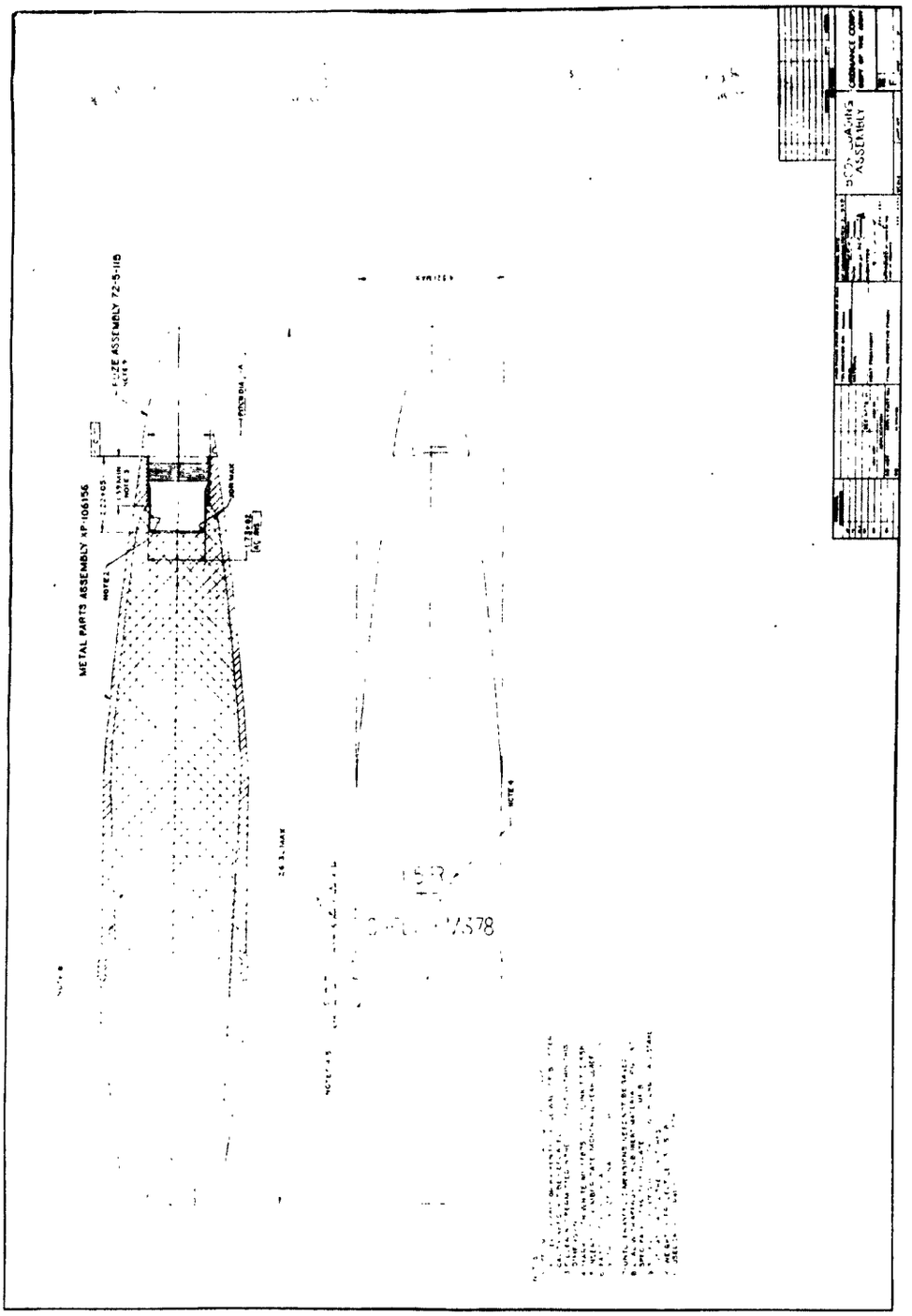
8. (U) Funds required for this test have been estimated at $4,000 per shell. Accordingly, since data from three shell are required, $12,000 is furnished herewith. In the event of an unusual occurrence which necessitates additional testing, funds will be furnished subsequently. Funds amounting to $12,000 on AIF Order No. 07110100-99-60037 have been forwarded.

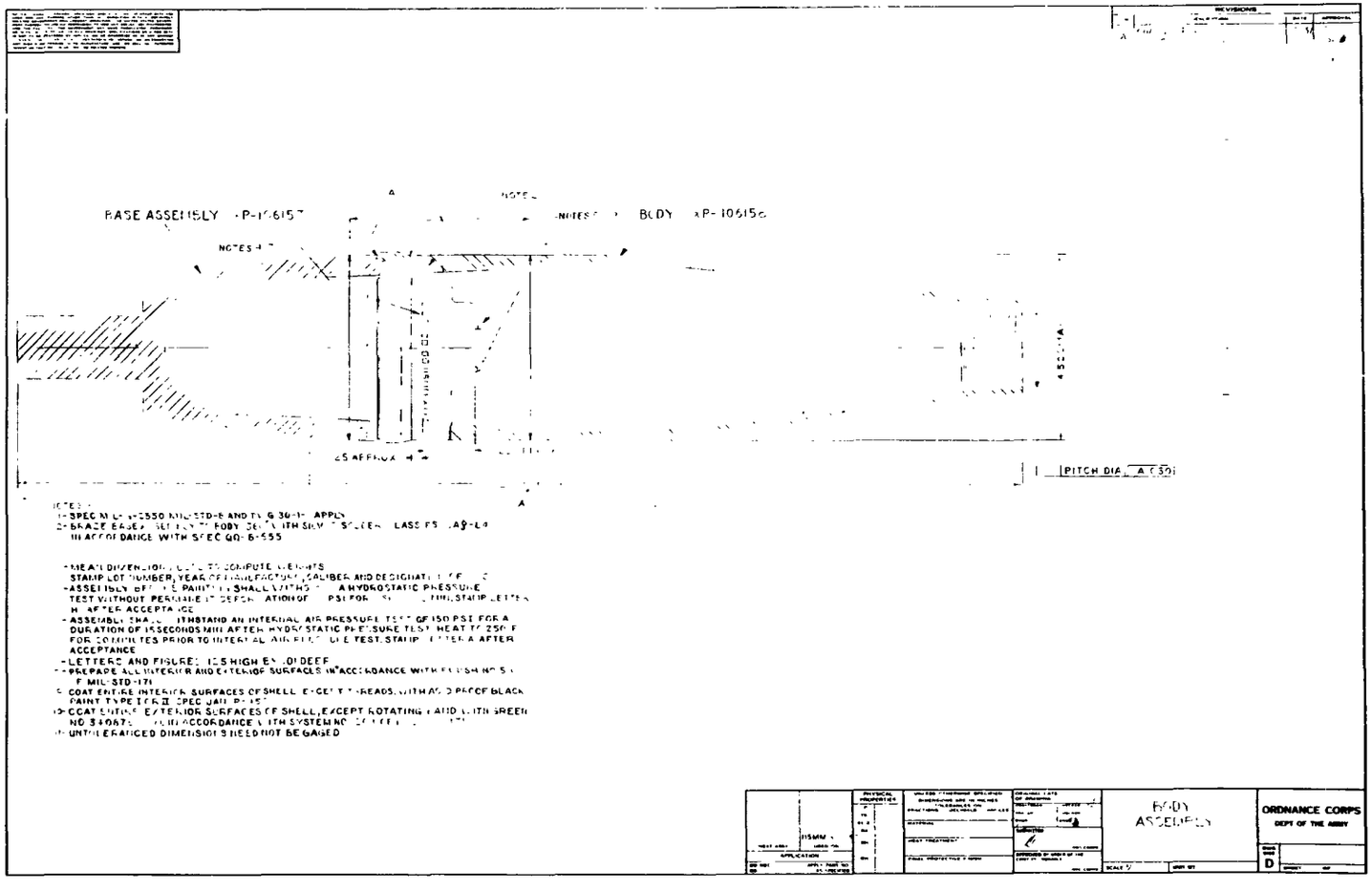
FOR THE COMMANDER:

W. F. [illegible]
A[illegible]t

2 Incls
1-2. Prts Dwgs. Nos. DXP-106156 (2) and -107800 (x)

CC
APG, ORDBG-D&PS,
Analytical Lab
APG, ORDBG-ERL,
Wpns Systems Lab,
w/Incls 1 & 2


METAL PARTS ASSEMBLY XP-106156
FUZE ASSEMBLY 72-5-115




NOTES:
1. SPEC MIL-P-2550 AND STD-B AND TYPE G 30-H APPLY
2. BRAZE BASE ASSEMBLY TO BODY WITH SILVER SOLDER CLASS FS AG-4
3. IN ACCORDANCE WITH SPEC QQ-B-555

4. MEAN DIMENSIONS ARE TO COMPUTE WEIGHTS
5. STAMP LOT NUMBER, YEAR OF MANUFACTURE, CALIBER AND DESIGNATION OF
6. ASSEMBLY BEFORE PAINTING SHALL WITHSTAND A HYDROSTATIC PRESSURE TEST WITHOUT PERMANENT DEFORMATION OF PSI FOR SECONDS, STAMP LETTER H AFTER ACCEPTANCE
7. ASSEMBLY SHALL WITHSTAND AN INTERNAL AIR PRESSURE TEST OF 150 PSI FOR A DURATION OF 15 SECONDS MIN AFTER HYDROSTATIC PRESSURE TEST HEAT TO 250 F FOR 30 MINUTES PRIOR TO INTERNAL AIR PRESSURE TEST. STAMP LETTER A AFTER ACCEPTANCE
8. LETTERS AND FIGURES .125 HIGH BY .01 DEEP
9. PREPARE ALL INTERIOR AND EXTERIOR SURFACES IN ACCORDANCE WITH FINISH NO S F MIL-STD-171
10. COAT ENTIRE INTERIOR SURFACES OF SHELL EXCEPT THREADS WITH ANTI-SEIZE PAINT TYPE I OR II SPEC MIL-P-
11. COAT ENTIRE EXTERIOR SURFACES OF SHELL, EXCEPT ROTATING BAND WITH GREEN NO 34087 IN ACCORDANCE WITH SYSTEM NO
12. UNTOLERANCED DIMENSIONS NEED NOT BE GAGED

| | | | | | |
|---|---|---|---|---|---|
| | | | | BODY ASSEMBLY | ORDNANCE CORPS DEPT OF THE ARMY |
| | | | | SCALE 5/ | SIZE D |

APPENDIX B

Individual Fragment Weights

115-mm, XM378
Round No. 1
4 November 1959

| Zone | Weight | Code |
|---|---|---|
| 1 | 945.00 | F |
| | 105.00 | F |
| | 14.84 | F |
| | 11.43 | F |
| | 6.36 | F |
| | 5.02 | F |
| | 4.98 | F |
| | 2.84 | F |
| | 2.13 | F |
| | 1.71 | F |
| | 1.54 | F |
| | 1.20 | F |
| | 0.34 | F |
| Total | 1102.39 | |
| 2 | 23.13 | F |
| | 21.92 | F |
| | 1.84 | F |
| | 0.75 | F |
| | 0.24 | F |
| Total | 47.88 | |
| 3 | NR | |
| 4 | 8.39 | |
| Total | 8.39 | |
| 5 | 86.22 | |
| | 22.58 | |
| | 5.35 | |
| | 4.74 | |
| | 4.11 | |
| | 2.58 | |
| | 1.94 | |
| | 1.24 | |
| | 0.46 | |
| | 0.43 | |
| Total | 129.65 | |

| Zone | Weight |
|---|---|
| 6 | 94.14 |
| | 11.10 |
| | 11.00 |
| | 4.77 |
| | 2.70 |
| | 2.42 |
| | 1.72 |
| | 0.80 |
| | 0.74 |
| | 0.50 |
| | 0.28 |
| Total | 130.17 |
| 7 | 15.80 |
| | 4.80 |
| | 3.06 |
| | 2.78 |
| | 2.72 |
| | 0.97 |
| | 0.20 |
| | 0.13 |
| Total | 30.46 |
| 8 | 5.00 |
| | 4.87 |
| | 3.50 |
| | 3.47 |
| | 2.55 |
| | 2.19 |
| | 1.89 |
| | 1.61 |
| | 1.50 |
| | 0.90 |
| | 0.71 |
| | 0.22 |
| | 0.21 |
| | 0.20 |
| | 0.15 |
| | 0.12 |

| Zone | Weight |
|---|---|
| 8 | 0.12 |
| | 0.10 |
| | 0.10 |
| | 0.10 |
| | 0.09 |
| | 0.07 |
| | 0.07 |
| | 0.05 |
| | 0.05 |
| | 0.03 |
| Total | 29.87 |
| 9 | 31.86 |
| | 20.70 |
| | 13.86 |
| | 11.77 |
| | 11.73 |
| | 9.09 |
| | 9.00 |
| | 8.73 |
| | 7.86 |
| | 7.55 |
| | 7.50 |
| | 7.40 |
| | 6.75 |
| | 6.69 |
| | 5.68 |
| | 5.60 |
| | 5.25 |
| | 5.02 |
| | 4.26 |
| | 4.22 |
| | 4.12 |
| | 4.05 |
| | 3.95 |
| | 3.94 |
| | 3.86 |
| | 3.77 |
| | 3.57 |
| | 3.28 |
| | 3.12 |

| Zone | Weight | Zone | Weight | Zone | Weight |
|---|---|---|---|---|---|
| 9 | 3.00 | 9 | 0.35 | 10 | 15.49 |
| | 2.91 | | 0.35 | | 14.70 |
| | 2.85 | | 0.30 | | 14.46 |
| | 2.69 | | 0.30 | | 14.39 |
| | 2.60 | | 0.26 | | 13.74 |
| | 2.40 | | 0.26 | | 13.62 |
| | 2.32 | | 0.25 | | 13.39 |
| | 2.17 | | 0.21 | | 12.98 |
| | 1.92 | | 0.21 | | 12.82 |
| | 1.80 | | 0.19 | | 12.49 |
| | 1.80 | | 0.18 | | 11.93 |
| | 1.74 | | 0.18 | | 11.19 |
| | 1.66 | | 0.17 | | 11.14 |
| | 1.59 | | 0.16 | | 10.96 |
| | 1.59 | | 0.16 | | 10.85 |
| | 1.50 | | 0.13 | | 10.62 |
| | 1.50 | | 0.12 | | 10.25 |
| | 1.48 | | 0.12 | | 9.65 |
| | 1.48 | | 0.10 | | 9.60 |
| | 1.45 | | 0.10 | | 9.55 |
| | 1.35 | | 0.10 | | 9.42 |
| | 1.30 | | 0.10 | | 9.30 |
| | 1.30 | | 0.09 | | 9.25 |
| | 1.22 | | 0.08 | | 9.06 |
| | 1.14 | | 0.08 | | 8.89 |
| | 1.06 | | 0.07 | | 8.80 |
| | 1.00 | | 0.07 | | 8.73 |
| | 0.95 | | 0.06 | | 8.72 |
| | 0.95 | | 0.06 | | 8.53 |
| | 0.93 | | 0.05 | | 8.50 |
| | 0.91 | | 0.05 | | 8.38 |
| | 0.86 | | 0.04 | | 8.32 |
| | 0.85 | | 0.03 | | 8.18 |
| | 0.84 | | | | 8.10 |
| | 0.72 | Total | 289.09 | | 7.74 |
| | 0.70 | | | | 7.65 |
| | 0.64 | 10 | 28.80 | | 7.49 |
| | 0.62 | | 21.10 | | 7.45 |
| | 0.57 | | 20.30 | | 7.44 |
| | 0.48 | | 20.24 | | 7.44 |
| | 0.38 | | 17.34 | | 7.42 |
| | 0.36 | | 16.95 | | 7.33 |
| | 0.35 | | 15.73 | | 6.95 |

| Zone | Weight | Zone | Weight | Zone | Weight |
|---|---|---|---|---|---|
| 10 | 6.90 | 10 | 2.80 | 10 | 1.76 |
| | 6.80 | | 2.80 | | 1.72 |
| | 6.75 | | 2.80 | | 1.69 |
| | 6.45 | | 2.80 | | 1.69 |
| | 6.34 | | 2.76 | | 1.67 |
| | 6.25 | | 2.72 | | 1.62 |
| | 6.23 | | 2.70 | | 1.60 |
| | 5.93 | | 2.69 | | 1.53 |
| | 5.85 | | 2.65 | | 1.52 |
| | 5.40 | | 2.65 | | 1.50 |
| | 5.13 | | 2.65 | | 1.49 |
| | 4.98 | | 2.60 | | 1.45 |
| | 4.97 | | 2.56 | | 1.45 |
| | 4.88 | | 2.56 | | 1.44 |
| | 4.80 | | 2.51 | | 1.39 |
| | 4.78 | | 2.50 | | 1.36 |
| | 4.55 | | 2.43 | | 1.36 |
| | 4.47 | | 2.42 | | 1.36 |
| | 4.46 | | 2.40 | | 1.32 |
| | 4.35 | | 2.39 | | 1.30 |
| | 4.30 | | 2.35 | | 1.25 |
| | 4.10 | | 2.33 | | 1.18 |
| | 4.08 | | 2.17 | | 1.15 |
| | 4.07 | | 2.17 | | 1.06 |
| | 3.90 | | 2.12 | | 1.06 |
| | 3.90 | | 2.10 | | 1.06 |
| | 3.80 | | 2.10 | | 1.00 |
| | 3.80 | | 2.09 | | 0.97 |
| | 3.65 | | 2.05 | | 0.96 |
| | 3.64 | | 2.05 | | 0.94 |
| | 3.56 | | 2.00 | | 0.94 |
| | 3.55 | | 1.91 | | 0.90 |
| | 3.50 | | 1.90 | | 0.90 |
| | 3.29 | | 1.86 | | 0.90 |
| | 3.25 | | 1.86 | | 0.90 |
| | 3.16 | | 1.82 | | 0.90 |
| | 3.15 | | 1.80 | | 0.86 |
| | 3.11 | | 1.80 | | 0.85 |
| | 3.10 | | 1.80 | | 0.85 |
| | 3.02 | | 1.80 | | 0.85 |
| | 3.00 | | 1.76 | | 0.83 |
| | 2.90 | | 1.76 | | 0.82 |
| | 2.83 | | 1.76 | | 0.80 |
| | | | | | 0.77 |

| Zone | Weight |
|---|---|
| 10 | 0.77 |
| | 0.76 |
| | 0.75 |
| | 0.75 |
| | 0.75 |
| | 0.74 |
| | 0.74 |
| | 0.74 |
| | 0.73 |
| | 0.73 |
| | 0.73 |
| | 0.70 |
| | 0.68 |
| | 0.67 |
| | 0.67 |
| | 0.66 |
| | 0.66 |
| | 0.65 |
| | 0.64 |
| | 0.64 |
| | 0.60 |
| | 0.60 |
| | 0.58 |
| | 0.56 |
| | 0.55 |
| | 0.55 |
| | 0.55 |
| | 0.54 |
| | 0.53 |
| | 0.53 |
| | 0.52 |
| | 0.52 |
| | 0.51 |
| | 0.50 |
| | 0.50 |
| | 0.50 |
| | 0.50 |
| | 0.48 |
| | 0.48 |
| | 0.47 |
| | 0.46 |
| | 0.45 |
| | 0.43 |
| | 0.43 |
| | 0.42 |
| | 0.42 |
| | 0.42 |
| | 0.40 |
| | 0.40 |
| | 0.38 |

| Zone | Weight |
|---|---|
| 10 | 0.35 |
| | 0.34 |
| | 0.33 |
| | 0.32 |
| | 0.32 |
| | 0.32 |
| | 0.32 |
| | 0.32 |
| | 0.30 |
| | 0.30 |
| | 0.29 |
| | 0.28 |
| | 0.28 |
| | 0.25 |
| | 0.25 |
| | 0.25 |
| | 0.25 |
| | 0.23 |
| | 0.22 |
| | 0.22 |
| | 0.22 |
| | 0.21 |
| | 0.20 |
| | 0.20 |
| | 0.20 |
| | 0.20 |
| | 0.18 |
| | 0.18 |
| | 0.18 |
| | 0.18 |
| | 0.17 |
| | 0.17 |
| | 0.16 |
| | 0.16 |
| | 0.16 |
| | 0.16 |
| | 0.15 |
| | 0.15 |
| | 0.15 |
| | 0.15 |
| | 0.14 |
| | 0.12 |
| | 0.12 |
| | 0.12 |
| | 0.12 |
| | 0.12 |
| | 0.12 |
| | 0.12 |

| Zone | Weight |
|---|---|
| 10 | 0.11 |
| | 0.10 |
| | 0.10 |
| | 0.10 |
| | 0.10 |
| | 0.09 |
| | 0.09 |
| | 0.09 |
| | 0.09 |
| | 0.09 |
| | 0.09 |
| | 0.07 |
| | 0.06 |
| | 0.05 |
| | 0.05 |
| | 0.05 |
| | 0.05 |
| | 0.05 |
| | 0.04 |
| | 0.04 |
| | 0.04 |
| | 0.03 |
| | 0.03 |
| | 0.03 |
| | 0.03 |
| | 0.03 |
| | 0.03 |
| | 0.03 |
| | 0.03 |
| | 0.02 |
| | 0.02 |
| | 0.02 |
| | 0.02 |
| | 0.02 |
| | 0.02 |
| | 0.02 |
| Total | 956.23 |
| 11 | 108.00 |
| | 105.00 |
| | 92.60 |
| | 91.00 |
| | 88.80 |
| | 71.20 |
| | 68.28 |
| | 61.80 |
| | 59.64 |

| Zone | Weight |
|---|---|
| 11 | 58.60 |
| | 56.66 |
| | 54.84 |
| | 54.00 |
| | 45.58 |
| | 42.44 |
| | 41.00 |
| | 40.60 |
| | 39.58 |
| | 37.20 |
| | 34.00 |
| | 33.82 |
| | 33.78 |
| | 32.20 |
| | 32.18 |
| | 31.70 |
| | 30.24 |
| | 29.62 |
| | 29.30 |
| | 29.06 |
| | 28.75 |
| | 28.18 |
| | 27.45 |
| | 27.17 |
| | 26.08 |
| | 24.80 |
| | 23.68 |
| | 23.45 |
| | 23.38 |
| | 23.25 |
| | 22.65 |
| | 22.62 |
| | 22.24 |
| | 22.14 |
| | 21.45 |
| | 20.06 |
| | 19.94 |
| | 19.70 |
| | 19.67 |
| | 19.60 |
| | 19.10 |
| | 18.85 |
| | 18.71 |
| | 18.69 |
| | 18.62 |
| | 17.75 |
| | 17.60 |
| | 17.58 |
| | 17.14 |
| | 17.09 |

| Zone | Weight |
|---|---|
| 11 | 17.05 |
| | 16.57 |
| | 16.27 |
| | 16.13 |
| | 15.97 |
| | 15.96 |
| | 15.62 |
| | 15.53 |
| | 15.28 |
| | 15.00 |
| | 15.00 |
| | 14.69 |
| | 14.65 |
| | 14.56 |
| | 14.46 |
| | 14.17 |
| | 14.12 |
| | 14.10 |
| | 14.07 |
| | 14.01 |
| | 13.80 |
| | 13.41 |
| | 13.21 |
| | 13.07 |
| | 13.03 |
| | 12.89 |
| | 12.79 |
| | 12.71 |
| | 12.60 |
| | 12.53 |
| | 12.10 |
| | 11.92 |
| | 11.82 |
| | 11.60 |
| | 11.55 |
| | 11.46 |
| | 11.12 |
| | 10.80 |
| | 10.80 |
| | 10.79 |
| | 10.75 |
| | 10.75 |
| | 10.70 |
| | 10.61 |
| | 10.60 |
| | 10.52 |
| | 10.45 |
| | 10.44 |
| | 10.15 |
| | 9.99 |

| Zone | Weight |
|---|---|
| 11 | 9.87 |
| | 9.84 |
| | 9.53 |
| | 9.46 |
| | 9.40 |
| | 9.25 |
| | 9.25 |
| | 9.23 |
| | 9.05 |
| | 9.02 |
| | 8.90 |
| | 8.85 |
| | 8.84 |
| | 8.77 |
| | 8.74 |
| | 8.58 |
| | 8.53 |
| | 8.50 |
| | 8.35 |
| | 8.30 |
| | 8.27 |
| | 8.20 |
| | 8.13 |
| | 8.05 |
| | 7.98 |
| | 7.91 |
| | 7.67 |
| | 7.66 |
| | 7.56 |
| | 7.55 |
| | 7.38 |
| | 7.37 |
| | 7.35 |
| | 7.35 |
| | 7.25 |
| | 7.23 |
| | 7.10 |
| | 7.09 |
| | 7.07 |
| | 7.04 |
| | 7.04 |
| | 6.97 |
| | 6.95 |
| | 6.94 |
| | 6.94 |
| | 6.93 |
| | 6.80 |
| | 6.70 |
| | 6.60 |
| | 6.53 |

| Zone | Weight | Zone | Weight | Zone | Weight |
|---|---|---|---|---|---|
| 11 | 6.32 | 11 | 4.06 | 11 | 3.00 |
| | 6.30 | | 4.03 | | 3.00 |
| | 5.85 | | 4.02 | | 2.92 |
| | 5.77 | | 4.00 | | 2.92 |
| | 5.76 | | 4.00 | | 2.85 |
| | 5.75 | | 4.00 | | 2.83 |
| | 5.74 | | 3.97 | | 2.80 |
| | 5.74 | | 3.96 | | 2.76 |
| | 5.69 | | 3.92 | | 2.76 |
| | 5.67 | | 3.87 | | 2.72 |
| | 5.63 | | 3.86 | | 2.70 |
| | 5.60 | | 3.85 | | 2.62 |
| | 5.48 | | 3.83 | | 2.50 |
| | 5.45 | | 3.82 | | 2.50 |
| | 5.39 | | 2.75 | | 2.45 |
| | 5.38 | | 3.74 | | 2.45 |
| | 5.30 | | 3.70 | | 2.44 |
| | 5.30 | | 3.69 | | 2.41 |
| | 5.20 | | 3.68 | | 2.39 |
| | 5.18 | | 3.60 | | 2.39 |
| | 5.16 | | 3.57 | | 2.35 |
| | 5.13 | | 3.56 | | 2.34 |
| | 5.12 | | 3.55 | | 2.31 |
| | 5.11 | | 3.55 | | 2.31 |
| | 5.10 | | 3.52 | | 2.30 |
| | 5.00 | | 3.50 | | 2.30 |
| | 4.88 | | 3.50 | | 2.29 |
| | 4.77 | | 3.49 | | 2.28 |
| | 4.76 | | 3.44 | | 2.28 |
| | 4.75 | | 3.40 | | 2.27 |
| | 4.68 | | 3.36 | | 2.26 |
| | 4.68 | | 3.34 | | 2.24 |
| | 4.67 | | 3.32 | | 2.24 |
| | 4.63 | | 3.31 | | 2.19 |
| | 4.62 | | 3.30 | | 2.18 |
| | 4.60 | | 3.29 | | 2.17 |
| | 4.59 | | 3.28 | | 2.16 |
| | 4.58 | | 3.24 | | 2.00 |
| | 4.53 | | 3.22 | | 2.00 |
| | 4.53 | | 3.20 | | 1.99 |
| | 4.40 | | 3.20 | | 1.95 |
| | 4.37 | | 3.19 | | 1.94 |
| | 4.35 | | 3.17 | | 1.91 |
| | 4.33 | | 3.12 | | 1.90 |
| | 4.24 | | 3.11 | | 1.90 |
| | 4.21 | | 3.11 | | 1.90 |
| | 4.20 | | 3.07 | | 1.89 |
| | 4.16 | | 3.05 | | 1.89 |
| | 4.11 | | 3.02 | | 1.85 |
| | 4.08 | | 3.01 | | 1.82 |

| Zone | Weight | Zone | Weight | Zone | Weight |
|---|---|---|---|---|---|
| 11 | 1.82 | 11 | 1.24 | 11 | 0.81 |
| | 1.78 | | 1.20 | | 0.81 |
| | 1.75 | | 1.19 | | 0.80 |
| | 1.74 | | 1.18 | | 0.79 |
| | 1.69 | | 1.14 | | 0.79 |
| | 1.69 | | 1.12 | | 0.78 |
| | 1.67 | | 1.10 | | 0.77 |
| | 1.67 | | 1.09 | | 0.76 |
| | 1.65 | | 1.09 | | 0.75 |
| | 1.64 | | 1.09 | | 0.75 |
| | 1.62 | | 1.06 | | 0.74 |
| | 1.60 | | 1.05 | | 0.73 |
| | 1.60 | | 1.05 | | 0.70 |
| | 1.59 | | 1.04 | | 0.69 |
| | 1.58 | | 1.04 | | 0.66 |
| | 1.57 | | 1.04 | | 0.65 |
| | 1.57 | | 1.03 | | 0.65 |
| | 1.57 | | 1.03 | | 0.64 |
| | 1.55 | | 1.02 | | 0.64 |
| | 1.54 | | 1.02 | | 0.62 |
| | 1.53 | | 1.00 | | 0.62 |
| | 1.50 | | 1.00 | | 0.62 |
| | 1.50 | | 0.99 | | 0.62 |
| | 1.50 | | 0.99 | | 0.61 |
| | 1.50 | | 0.99 | | 0.60 |
| | 1.49 | | 0.98 | | 0.58 |
| | 1.45 | | 0.98 | | 0.58 |
| | 1.43 | | 0.97 | | 0.57 |
| | 1.42 | | 0.96 | | 0.56 |
| | 1.41 | | 0.94 | | 0.55 |
| | 1.40 | | 0.94 | | 0.55 |
| | 1.39 | | 0.93 | | 0.55 |
| | 1.39 | | 0.93 | | 0.55 |
| | 1.39 | | 0.92 | | 0.54 |
| | 1.39 | | 0.92 | | 0.53 |
| | 1.36 | | 0.90 | | 0.52 |
| | 1.35 | | 0.90 | | 0.51 |
| | 1.34 | | 0.90 | | 0.50 |
| | 1.33 | | 0.90 | | 0.50 |
| | 1.32 | | 0.90 | | 0.50 |
| | 1.31 | | 0.90 | | 0.50 |
| | 1.30 | | 0.89 | | 0.49 |
| | 1.29 | | 0.89 | | 0.49 |
| | 1.27 | | 0.86 | | 0.46 |
| | 1.26 | | 0.86 | | 0.46 |
| | 1.25 | | 0.85 | | 0.44 |
| | 1.24 | | 0.85 | | 0.44 |
| | 1.22 | | 0.85 | | 0.44 |
| | 1.22 | | 0.84 | | 0.41 |
| | 1.22 | | 0.82 | | 0.40 |

| Zone | Weight | Zone | Weight | Zone | Weight |
|---|---|---|---|---|---|
| 11 | 0.40 | 11 | 0.22 | 11 | 0.10 |
| | 0.40 | | 0.21 | | 0.10 |
| | 0.39 | | 0.20 | | 0.10 |
| | 0.39 | | 0.20 | | 0.10 |
| | 0.39 | | 0.20 | | 0.10 |
| | 0.38 | | 0.20 | | 0.10 |
| | 0.38 | | 0.20 | | 0.09 |
| | 0.38 | | 0.20 | | 0.09 |
| | 0.36 | | 0.20 | | 0.09 |
| | 0.36 | | 0.19 | | 0.09 |
| | 0.36 | | 0.19 | | 0.09 |
| | 0.35 | | 0.18 | | 0.08 |
| | 0.35 | | 0.18 | | 0.08 |
| | 0.35 | | 0.17 | | 0.08 |
| | 0.35 | | 0.17 | | 0.08 |
| | 0.34 | | 0.17 | | 0.08 |
| | 0.34 | | 0.17 | | 0.08 |
| | 0.33 | | 0.17 | | 0.08 |
| | 0.33 | | 0.16 | | 0.08 |
| | 0.33 | | 0.16 | | 0.08 |
| | 0.33 | | 0.16 | | 0.08 |
| | 0.32 | | 0.16 | | 0.08 |
| | 0.32 | | 0.16 | | 0.08 |
| | 0.32 | | 0.16 | | 0.08 |
| | 0.30 | | 0.15 | | 0.08 |
| | 0.30 | | 0.15 | | 0.08 |
| | 0.30 | | 0.15 | | 0.08 |
| | 0.30 | | 0.15 | | 0.08 |
| | 0.30 | | 0.15 | | 0.08 |
| | 0.30 | | 0.15 | | 0.08 |
| | 0.29 | | 0.15 | | 0.08 |
| | 0.29 | | 0.14 | | 0.08 |
| | 0.29 | | 0.14 | | 0.08 |
| | 0.29 | | 0.14 | | 0.07 |
| | 0.29 | | 0.13 | | 0.07 |
| | 0.29 | | 0.13 | | 0.07 |
| | 0.28 | | 0.13 | | 0.07 |
| | 0.28 | | 0.12 | | 0.07 |
| | 0.28 | | 0.12 | | 0.07 |
| | 0.27 | | 0.12 | | 0.07 |
| | 0.26 | | 0.12 | | 0.07 |
| | 0.26 | | 0.12 | | 0.07 |
| | 0.25 | | 0.11 | | 0.06 |
| | 0.25 | | 0.10 | | 0.06 |
| | 0.24 | | 0.10 | | 0.06 |
| | 0.24 | | 0.10 | | 0.06 |
| | 0.24 | | 0.10 | | 0.06 |
| | 0.24 | | 0.10 | | 0.06 |
| | 0.24 | | 0.10 | | 0.06 |
| | 0.23 | | 0.10 | | 0.06 |

| Zone | Weight |
|---|---|
| 11 | 0.06 |
| | 0.06 |
| | 0.05 |
| | 0.05 |
| | 0.05 |
| | 0.05 |
| | 0.05 |
| | 0.05 |
| | 0.05 |
| | 0.05 |
| | 0.05 |
| | 0.05 |
| | 0.05 |
| | 0.05 |
| | 0.05 |
| | 0.05 |
| | 0.05 |
| | 0.05 |
| | 0.05 |
| | 0.05 |
| | 0.05 |
| | 0.04 |
| | 0.04 |
| | 0.04 |
| | 0.04 |
| | 0.04 |
| | 0.04 |
| | 0.04 |
| | 0.04 |
| | 0.03 |
| | 0.03 |
| | 0.03 |
| | 0.03 |
| | 0.03 |
| | 0.03 |
| | 0.03 |
| | 0.03 |
| | 0.03 |
| | 0.03 |
| | 0.02 |
| | 0.02 |
| | 0.02 |
| | 0.02 |
| | 0.02 |
| | 0.02 |

| Zone | Weight |
|---|---|
| 11 | 0.02 |
| | 0.02 |
| | 0.02 |
| | 0.02 |
| | 0.02 |
| | 0.02 |
| | 0.01 |
| | 0.01 |
| | 0.01 |
| | 0.01 |
| | 0.01 |
| | 0.01 |
| | 0.01 |
| | 0.01 |
| | 0.01 |
| | 0.01 |
| | 0.01 |
| | 0.01 |
| | 0.01 |
| | 0.01 |
| | 0.01 |
| | 0.01 |
| | 0.01 |
| | 0.01 |
| | 0.01 |
| | 0.01 |
| | 0.01 |
| Total | 3948.63 |
| 12 | 13.92 |
| | 11.78 |
| | 10.39 |
| | 10.10 |
| | 8.65 |
| | 8.46 |
| | 5.60 |
| | 5.22 |
| | 4.90 |
| | 4.61 |
| | 3.65 |
| | 3.65 |
| | 3.31 |
| | 3.17 |
| | 2.95 |
| | 2.93 |
| | 2.90 |
| | 2.73 |
| | 2.04 |

| Zone | Weight |
|---|---|
| 12 | 1.99 |
| | 1.89 |
| | 1.65 |
| | 1.56 |
| | 1.55 |
| | 1.65 |
| | 1.32 |
| | 1.30 |
| | 1.29 |
| | 1.28 |
| | 1.22 |
| | 1.14 |
| | 0.98 |
| | 0.98 |
| | 0.91 |
| | 0.80 |
| | 0.80 |
| | 0.80 |
| | 0.65 |
| | 0.64 |
| | 0.60 |
| | 0.53 |
| | 0.48 |
| | 0.44 |
| | 0.42 |
| | 0.35 |
| | 0.33 |
| | 0.32 |
| | 0.32 |
| | 0.30 |
| | 0.27 |
| | 0.27 |
| | 0.22 |
| | 0.20 |
| | 0.18 |
| | 0.17 |
| | 0.16 |
| | 0.16 |
| | 0.15 |
| | 0.13 |
| | 0.09 |
| | 0.07 |
| | 0.06 |
| | 0.05 |
| | 0.05 |
| | 0.05 |
| | 0.03 |
| | 0.01 |
| Total | 141.77 |

| Zone | Weight | Zone | Weight | Zone | Weight |
|---|---|---|---|---|---|
| 13 | 32.40 | 13 | 1.93 | 14 | 0.24 |
| | 29.76 | | 1.75 | | 0.21 |
| | 25.47 | | 1.69 | | 0.20 |
| | 15.45 | | 1.65 | | 0.17 |
| | 13.70 | | 1.49 | | 0.15 |
| | 12.17 | | 1.25 | | 0.14 |
| | 10.95 | | 1.15 | | 0.09 |
| | 10.75 | | 1.14 | | 0.07 |
| | 10.17 | | 1.10 | | 0.05 |
| | 10.04 | | 1.00 | | 0.05 |
| | 9.82 | | 0.92 | | 0.04 |
| | 9.60 | | 0.89 | | |
| | 8.55 | | 0.87 | Total | 63.99 |
| | 7.80 | | 0.86 | | |
| | 7.62 | | 0.74 | 15 | 19.05 |
| | 7.55 | | 0.60 | | 3.82 |
| | 7.37 | | 0.58 | | 3.50 |
| | 7.14 | | 0.42 | | 3.33 |
| | 6.32 | | 0.38 | | 3.29 |
| | 6.22 | | 0.25 | | 2.68 |
| | 6.15 | | 0.20 | | 1.50 |
| | 6.10 | | 0.18 | | 1.14 |
| | 6.04 | | 0.30 | | 0.85 |
| | 5.55 | | 0.16 | | 0.80 |
| | 5.36 | | 0.15 | | 0.65 |
| | 5.13 | | 0.14 | | 0.65 |
| | 7.04 | | 0.11 | | 0.64 |
| | 4.40 | | 0.10 | | 0.63 |
| | 4.48 | | 0.08 | | 0.60 |
| | 3.85 | | 0.06 | | 0.60 |
| | 3.26 | | 0.04 | | 0.59 |
| | 3.25 | | 0.03 | | 0.47 |
| | 3.44 | | | | 0.38 |
| | 3.18 | Total | 380.31 | | |
| | 3.17 | | | Total | 45.17 |
| | 3.07 | 14 | 25.27 | | |
| | 2.97 | | 8.14 | 16 | 3.44 |
| | 2.86 | | 6.67 | | 1.85 |
| | 2.82 | | 4.65 | | 0.45 |
| | 2.80 | | 4.49 | | 0.35 |
| | 2.78 | | 2.98 | | |
| | 2.77 | | 2.29 | Total | 6.09 |
| | 2.73 | | 2.09 | | |
| | 2.52 | | 1.97 | 17 | 19.20 |
| | 2.41 | | 1.69 | | 18.52 |
| | 2.36 | | 0.74 | | 12.30 |
| | 2.30 | | 0.55 | | 11.14 |
| | 2.27 | | 0.50 | | 10.78 |
| | 2.13 | | 0.30 | | 10.69 |
| | 2.06 | | 0.25 | | 9.78 |

| Zone | Weight | Zone | Weight | Zone | Weight |
|---|---|---|---|---|---|
| 17 | 8.75 | 17 | 0.65 | 17 | 0.14 |
| | 8.53 | | 0.59 | | 0.14 |
| | 8.00 | | 0.55 | | 0.14 |
| | 6.06 | | 0.55 | | 0.13 |
| | 5.75 | | 0.54 | | 0.12 |
| | 5.75 | | 0.53 | | 0.12 |
| | 5.57 | | 0.52 | | 0.12 |
| | 5.02 | | 0.51 | | 0.12 |
| | 5.00 | | 0.48 | | 0.11 |
| | 4.42 | | 0.47 | | 0.10 |
| | 4.26 | | 0.44 | | 0.10 |
| | 3.87 | | 0.44 | | 0.10 |
| | 3.56 | | 0.41 | | 0.10 |
| | 2.82 | | 0.40 | | 0.09 |
| | 2.70 | | 0.39 | | 0.09 |
| | 2.64 | | 0.38 | | 0.09 |
| | 2.54 | | 0.38 | | 0.08 |
| | 2.37 | | 0.38 | | 0.08 |
| | 2.30 | | 0.37 | | 0.06 |
| | 2.17 | | 0.34 | | 0.05 |
| | 2.11 | | 0.34 | | 0.05 |
| | 2.00 | | 0.33 | | 0.04 |
| | 1.99 | | 0.33 | | 0.04 |
| | 1.94 | | 0.30 | | 0.04 |
| | 1.86 | | 0.29 | | 0.02 |
| | 1.80 | | 0.28 | | 0.95 |
| | 1.80 | | 0.28 | | 0.98 |
| | 1.80 | | 0.26 | | 0.90 |
| | 1.79 | | 0.25 | | 0.89 |
| | 1.75 | | 0.25 | | |
| | 1.65 | | 0.23 | Total | 249.29 |
| | 1.65 | | 0.23 | | |
| | 1.64 | | 0.22 | 18 | 22.15 |
| | 1.60 | | 0.20 | | 20.69 |
| | 1.52 | | 0.20 | | 20.00 |
| | 1.49 | | 0.20 | | 19.78 |
| | 1.45 | | 0.20 | | 16.30 |
| | 1.30 | | 0.20 | | 15.80 |
| | 1.25 | | 0.20 | | 14.23 |
| | 1.17 | | 0.19 | | 12.68 |
| | 1.14 | | 0.18 | | 12.09 |
| | 1.11 | | 0.18 | | 11.92 |
| | 1.06 | | 0.17 | | 11.50 |
| | 1.00 | | 0.16 | | 10.10 |
| | 1.00 | | 0.15 | | 9.89 |
| | 0.89 | | 0.15 | | 9.48 |
| | 0.86 | | 0.15 | | 8.30 |
| | 0.85 | | 0.15 | | 8.84 |
| | 0.78 | | 0.14 | | 8.64 |
| | 0.69 | | 0.14 | | 7.82 |

| Zone | Weight | Code | Zone | Weight | Grain | Zone | Weight | Code |
|---|---|---|---|---|---|---|---|---|
| 18 | 7.62 | | 18 | 1.84 | | 18 | 0.57 | |
| | 5.85 | | | 1.80 | | | 0.54 | B |
| | 5.70 | | | 1.80 | | | 0.49 | |
| | 5.58 | | | 1.73 | | | 0.46 | |
| | 5.42 | | | 1.75 | | | 0.44 | |
| | 5.18 | | | 1.64 | | | 0.43 | B |
| | 4.97 | | | 1.62 | | | 0.43 | |
| | 4.93 | | | 1.62 | | | 0.40 | |
| | 4.94 | | | 1.60 | | | 0.39 | |
| | 4.78 | | | 1.50 | | | 0.38 | |
| | 4.74 | | | 1.50 | | | 0.38 | |
| | 4.20 | | | 1.49 | | | 0.35 | |
| | 4.20 | | | 1.46 | | | 0.35 | |
| | 4.05 | | | 1.42 | | | 0.34 | |
| | 3.60 | | | 1.42 | | | 0.33 | |
| | 3.55 | | | 1.40 | | | 0.32 | |
| | 3.48 | | | 1.37 | | | 0.32 | |
| | 3.41 | | | 1.36 | | | 0.31 | |
| | 3.35 | | | 1.35 | | | 0.30 | |
| | 3.28 | | | 1.27 | | | 0.30 | |
| | 3.11 | | | 1.27 | | | 0.30 | B |
| | 2.94 | | | 1.25 | | | 0.25 | |
| | 2.89 | | | 1.25 | | | 0.21 | |
| | 2.63 | | | 1.25 | | | 0.20 | |
| | 2.55 | | | 1.11 | | | 0.19 | |
| | 2.50 | | | 1.10 | | | 0.19 | |
| | 2.64 | | | 1.09 | | | 0.19 | |
| | 2.45 | | | 1.06 | | | 0.18 | |
| | 2.38 | | | 1.06 | | | 0.17 | |
| | 2.37 | | | 1.05 | | | 0.15 | |
| | 2.34 | | | 1.05 | | | 0.15 | |
| | 2.26 | | | 1.02 | | | 0.15 | |
| | 2.22 | B | | 1.02 | | | 0.15 | |
| | 2.15 | | | 1.02 | | | 0.14 | |
| | 2.07 | | | 0.99 | | | 0.12 | |
| | 2.02 | | | 0.97 | | | 0.12 | |
| | 2.02 | | | 0.87 | | | 0.11 | |
| | 2.00 | | | 0.80 | | | 0.10 | |
| | 2.00 | | | 0.75 | | | 0.10 | |
| | 2.03 | | | 0.69 | | | 0.09 | |
| | 1.97 | | | 0.69 | | | 0.09 | |
| | 1.95 | | | 0.67 | | | 0.09 | |
| | 1.92 | | | 0.66 | | | 0.08 | |
| | 1.92 | | | 0.65 | B | | 0.08 | |
| | 1.89 | | | 0.64 | | | 0.07 | |
| | 1.88 | | | 0.63 | | | 0.07 | |
| | 1.88 | | | 0.62 | | | 0.07 | |
| | 1.85 | | | 0.61 | | | 0.07 | |
| | 1.85 | | | 0.61 | | | 0.07 | |
| | 1.84 | | | 0.58 | | | 0.06 | |

| Zone | Weight | Code |
|---|---|---|
| 18 | 0.06 | |
| | 0.06 | |
| | 0.05 | |
| | 0.04 | |
| | 0.03 | |
| | 0.03 | |
| | 0.03 | |
| | 0.02 | |
| | 0.02 | |
| | 0.02 | |
| | 0.60 | |
| | 0.15 | |
| Total | 471.48 | |
| 19 | 83.06 | B |
| | 97.18 | B |
| | 76.20 | B |
| | 63.80 | B |
| | 45.74 | B |
| | 38.28 | B |
| | 34.18 | B |
| | 30.42 | B |
| | 31.80 | B |
| | 26.80 | B |
| | 16.85 | B |
| | 12.50 | B |
| | 8.14 | B |
| | 6.98 | B |
| | 4.89 | B |
| | 6.07 | B |
| | 3.21 | B |
| | 2.65 | B |
| | 1.94 | B |
| | 1.27 | B |
| | 0.82 | B |
| | 0.90 | B |
| | 0.85 | B |
| | 0.60 | B |
| | 0.65 | B |
| | 0.50 | B |
| | 0.44 | B |
| | 0.57 | B |
| | 0.67 | B |
| | 0.44 | B |
| | 0.34 | B |
| | 0.40 | B |
| | 0.47 | B |
| | 0.48 | B |
| | 0.30 | B |

| Zone | Weight | Grain |
|---|---|---|
| 19 | 0.39 | B |
| | 0.24 | B |
| | 0.30 | B |
| | 0.33 | B |
| | 0.30 | B |
| | 0.28 | B |
| | 0.35 | B |
| | 0.28 | B |
| | 0.25 | B |
| | 0.30 | B |
| | 0.22 | B |
| | 0.20 | B |
| | 0.35 | B |
| | 0.11 | B |
| | 0.14 | B |
| | 0.22 | B |
| | 0.12 | B |
| | 0.19 | B |
| | 0.25 | B |
| | 0.16 | B |
| | 0.12 | B |
| | 0.13 | B |
| | 0.22 | B |
| | 0.15 | B |
| | 0.15 | B |
| | 0.24 | B |
| | 0.19 | B |
| | 0.14 | B |
| | 0.10 | B |
| | 0.19 | B |
| | 0.18 | B |
| | 0.07 | B |
| | 0.09 | B |
| | 0.12 | B |
| | 0.06 | B |
| | 0.08 | B |
| | 0.09 | B |
| | 0.13 | B |
| | 0.07 | B |
| | 0.10 | B |
| | 0.09 | B |
| | 0.12 | B |
| | 0.09 | B |
| | 0.10 | B |
| | 0.05 | B |
| | 0.09 | B |
| | 0.05 | B |
| | 0.12 | B |
| | 0.10 | B |
| | 0.07 | B |

| Zone | Weight | Code |
|---|---|---|
| 19 | 0.10 | B |
| | 0.06 | B |
| | 0.06 | B |
| | 0.05 | B |
| | 0.05 | B |
| | 0.05 | B |
| | 0.03 | B |
| | 0.03 | B |
| | 0.02 | B |
| | 0.02 | B |
| | 0.03 | B |
| | 0.02 | B |
| | 0.01 | B |
| | 0.01 | B |
| | 0.01 | B |
| | 16.10 | |
| | 8.97 | |
| | 5.97 | |
| | 7.13 | |
| | 6.55 | |
| | 5.07 | |
| | 5.25 | |
| | 3.45 | |
| | 3.63 | |
| | 3.25 | |
| | 3.00 | |
| | 2.54 | |
| | 1.35 | |
| | 1.74 | |
| | 2.02 | |
| | 2.47 | |
| | 1.65 | |
| | 0.85 | |
| | 1.00 | |
| | 0.80 | |
| | 0.76 | |
| | 0.39 | |
| | 0.38 | |
| | 0.22 | |
| | 0.21 | |
| | 0.19 | |
| | 0.14 | |
| | 0.10 | |
| | 0.07 | |
| | 0.14 | |
| | 0.12 | |
| | 0.08 | |
| | 0.15 | |
| | 0.05 | |
| | 0.05 | |

| Zone | Weight |
|---|---|
| 19 | 0.05 |
| | 0.03 |
| | 0.02 |
| | 0.06 |
| | 0.03 |
| Total | 695.45 |
| 18B | 5.92 |
| | 3.00 |
| | 3.55 |
| | 3.52 |
| | 3.64 |
| | 2.10 |
| | 1.65 |
| | 1.74 |
| | 1.57 |
| | 1.40 |
| | 1.82 |
| | 1.16 |
| | 1.72 |
| | 1.37 |
| | 0.83 |
| | 0.85 |
| | 0.52 |
| | 0.30 |
| | 0.35 |
| | 0.30 |
| | 0.18 |
| | 0.20 |
| | 0.12 |
| | 0.30 |
| | 0.04 |
| | 0.16 |
| | 0.25 |
| | 0.15 |
| | 0.18 |
| | 0.14 |
| Total | 39.03 |
| 19B | 11.29 |
| | 10.30 |
| | 2.09 |
| | 1.50 |
| | 0.84 |
| | 0.08 |
| | 0.08 |
| Total | 26.18 |

| Zone | Weight | Code |
|---|---|---|
| 1N | 13.67 | F |
| | 18.16 | F |
| | 12.97 | F |
| | 4.88 | F |
| | 4.53 | F |
| | 3.53 | F |
| | 4.10 | F |
| | 3.35 | F |
| | 3.53 | F |
| | 2.36 | F |
| | 1.21 | F |
| | 1.57 | F |
| | 0.75 | F |
| Total | 74.61 | |
| 2N | 5507.00 | F |
| | 0.99 | F |
| Total | 5507.99 | |

GRAND TOTAL

No. 1886

Weight Grains 14,374.12

Code: F - Fuze
B - Brass
NR - No Recovery

155-mm, XM378
Round No. 2
12 November 1959

| Zone | Weight | Code |
|---|---|---|
| 1 | 5185.00 | F |
| | 180.00 | F |
| | 33.20 | F |
| | 22.90 | F |
| | 20.10 | F |
| | 12.60 | F |
| | 12.16 | F |
| | 10.37 | F |
| | 4.98 | F |
| | 4.73 | F |
| | 1.25 | F |
| | 1.30 | F |
| | 1.07 | F |
| | 1.08 | F |
| | 0.47 | F |
| | 0.65 | F |
| | 0.38 | F |
| | 0.70 | F |
| | 0.40 | F |
| | 0.39 | F |
| | 0.35 | F |
| | 0.40 | F |
| | 0.30 | F |
| | 0.42 | F |
| | 0.30 | F |
| | 0.19 | F |
| | 0.18 | F |
| | 0.14 | F |
| | 0.14 | F |
| | 0.16 | F |
| | 0.12 | F |
| | 0.13 | F |
| | 0.23 | F |
| | 0.20 | F |
| | 0.14 | F |
| | 0.10 | F |
| | 0.10 | F |
| | 0.09 | F |
| | 0.07 | F |
| | 0.08 | F |
| | 0.06 | F |
| Total | 5497.63 | |
| 2 | 703.00 | F |
| | 169.00 | F |
| | 101.00 | F |
| 2 | 68.20 | F |
| | 51.20 | F |
| | 22.82 | F |
| | 17.86 | F |
| | 7.50 | F |
| | 8.09 | F |
| | 6.25 | F |
| | 3.15 | F |
| | 2.00 | F |
| | 1.10 | F |
| | 1.42 | F |
| | 1.58 | F |
| | 1.45 | F |
| | 1.74 | F |
| | 0.88 | F |
| | 0.50 | F |
| | 1.00 | F |
| | 0.92 | F |
| | 0.75 | F |
| | 0.50 | F |
| | 0.30 | F |
| | 0.25 | F |
| | 0.34 | F |
| | 0.30 | F |
| | 0.14 | F |
| | 0.10 | F |
| | 0.10 | F |
| | 0.10 | F |
| | 0.12 | F |
| | 0.15 | F |
| | 0.10 | F |
| | 0.05 | F |
| Total | 1173.96 | |
| 3 | NR | |
| 4 | 0.22 | |
| | 0.17 | |
| | 0.18 | |
| | 0.09 | F |
| Total | 0.66 | |
| 5 | 176.00 | |
| | 2.78 | |
| | 1.36 | |
| 5 | 1.42 | |
| | 1.64 | |
| | 0.82 | |
| | 0.50 | |
| | 0.47 | |
| | 0.24 | |
| | 0.19 | |
| | 0.14 | |
| | 0.06 | |
| | 0.07 | |
| | 0.05 | |
| Total | 185.74 | |
| 6 | 111.00 | |
| | 96.80 | |
| | 25.36 | |
| | 12.50 | |
| | 11.79 | |
| | 3.03 | |
| | 2.37 | |
| | 2.92 | |
| | 0.70 | |
| | 0.43 | |
| | 0.20 | |
| | 0.13 | |
| | 0.20 | |
| | 0.05 | |
| Total | 267.48 | |
| 7 | 9.00 | |
| | 6.35 | |
| | 5.15 | |
| | 1.64 | |
| | 1.50 | |
| | 0.84 | |
| | 0.58 | |
| | 0.40 | |
| | 0.52 | |
| | 0.46 | |
| | 0.50 | |
| | 0.29 | |
| | 0.24 | |
| | 0.10 | |
| | 0.14 | |
| | 0.05 | |
| | 0.07 | |

| Zone | Weight |
|---|---|
| 7 | 0.04 |
| Total | 27.87 |
| 8 | 3.69 |
| | 4.00 |
| | 2.70 |
| | 3.20 |
| | 3.24 |
| | 1.87 |
| | 2.12 |
| | 1.32 |
| | 1.28 |
| | 1.08 |
| | 1.11 |
| | 0.96 |
| | 1.17 |
| | 0.60 |
| | 0.55 |
| | 0.34 |
| | 0.22 |
| | 0.32 |
| | 0.19 |
| | 0.14 |
| | 0.10 |
| | 0.12 |
| | 0.24 |
| | 0.10 |
| | 0.08 |
| | 0.04 |
| | 0.04 |
| | 0.04 |
| Total | 30.91 |
| 9 | 28.12 |
| | 19.18 |
| | 15.32 |
| | 15.00 |
| | 12.90 |
| | 13.08 |
| | 9.70 |
| | 9.40 |
| | 6.67 |
| | 7.40 |
| | 6.80 |
| | 4.86 |
| | 5.43 |
| | 4.51 |
| | 4.92 |
| | 3.28 |

| Zone | Weight |
|---|---|
| 9 | 4.52 |
| | 3.62 |
| | 4.50 |
| | 3.10 |
| | 3.55 |
| | 3.07 |
| | 3.54 |
| | 2.36 |
| | 3.12 |
| | 1.78 |
| | 1.80 |
| | 1.40 |
| | 1.55 |
| | 1.18 |
| | 1.43 |
| | 1.54 |
| | 1.09 |
| | 1.73 |
| | 1.87 |
| | 1.48 |
| | 0.95 |
| | 1.28 |
| | 1.25 |
| | 1.30 |
| | 1.10 |
| | 0.66 |
| | 1.06 |
| | 0.72 |
| | 0.65 |
| | 1.17 |
| | 0.69 |
| | 0.60 |
| | 0.45 |
| | 0.66 |
| | 0.31 |
| | 0.65 |
| | 0.32 |
| | 0.46 |
| | 0.47 |
| | 0.26 |
| | 0.55 |
| | 0.44 |
| | 0.30 |
| | 0.40 |
| | 0.25 |
| | 0.29 |
| | 0.35 |
| | 0.14 |
| | 0.15 |
| | 0.25 |
| | 0.14 |

| Zone | Weight |
|---|---|
| 9 | 0.15 |
| | 0.18 |
| | 0.11 |
| | 0.18 |
| | 0.10 |
| | 0.17 |
| | 0.08 |
| | 0.12 |
| | 0.05 |
| | 0.05 |
| | 0.04 |
| | 0.07 |
| | 0.07 |
| | 0.05 |
| | 0.04 |
| | 0.02 |
| Total | 234.55 |
| 10 | 41.00 |
| | 36.66 |
| | 30.26 |
| | 31.84 |
| | 26.07 |
| | 29.05 |
| | 24.58 |
| | 26.40 |
| | 21.84 |
| | 17.43 |
| | 21.27 |
| | 20.67 |
| | 14.75 |
| | 16.24 |
| | 14.15 |
| | 15.80 |
| | 15.62 |
| | 13.63 |
| | 14.70 |
| | 16.40 |
| | 17.80 |
| | 15.26 |
| | 12.53 |
| | 15.60 |
| | 14.18 |
| | 13.04 |
| | 12.74 |
| | 12.34 |
| | 12.46 |
| | 12.56 |
| | 8.45 |

| Zone | Weight | Zone | Weight | Zone | Weight |
|---|---|---|---|---|---|
| 10 | 9.60 | 10 | 4.21 | 10 | 0.98 |
| | 13.15 | | 3.35 | | 1.10 |
| | 10.32 | | 2.42 | | 1.20 |
| | 8.12 | | 2.90 | | 1.22 |
| | 10.62 | | 2.40 | | 1.55 |
| | 9.72 | | 3.10 | | 1.31 |
| | 7.83 | | 3.35 | | 0.70 |
| | 8.57 | | 3.25 | | 0.72 |
| | 6.05 | | 2.52 | | 1.16 |
| | 8.13 | | 4.25 | | 1.14 |
| | 8.24 | | 2.10 | | 0.95 |
| | 10.50 | | 3.32 | | 1.10 |
| | 8.35 | | 2.07 | | 0.89 |
| | 8.62 | | 2.68 | | 0.83 |
| | 7.60 | | 3.29 | | 0.64 |
| | 8.07 | | 2.97 | | 0.82 |
| | 5.50 | | 2.26 | | 0.48 |
| | 7.60 | | 2.26 | | 0.74 |
| | 7.40 | | 1.69 | | 0.68 |
| | 8.81 | | 3.05 | | 0.41 |
| | 8.85 | | 1.60 | | 0.50 |
| | 6.54 | | 2.82 | | 0.62 |
| | 7.24 | | 2.56 | | 0.40 |
| | 7.36 | | 2.53 | | 0.42 |
| | 4.80 | | 1.89 | | 0.67 |
| | 5.80 | | 1.79 | | 0.44 |
| | 4.72 | | 1.60 | | 0.69 |
| | 5.54 | | 1.90 | | 0.58 |
| | 5.39 | | 2.06 | | 0.30 |
| | 6.53 | | 1.76 | | 0.49 |
| | 5.84 | | 1.74 | | 0.27 |
| | 5.05 | | 3.10 | | 0.49 |
| | 6.64 | | 1.75 | | 0.48 |
| | 4.21 | | 1.75 | | 0.32 |
| | 4.74 | | 1.58 | | 0.34 |
| | 5.68 | | 1.33 | | 0.45 |
| | 5.68 | | 1.33 | | 0.35 |
| | 4.00 | | 1.75 | | 0.50 |
| | 4.32 | | 1.70 | | 0.55 |
| | 4.28 | | 2.05 | | 0.34 |
| | 3.99 | | 1.35 | | 0.32 |
| | 5.43 | | 1.45 | | 0.44 |
| | 3.80 | | 1.56 | | 0.50 |
| | 3.83 | | 1.76 | | 0.32 |
| | 4.00 | | 1.27 | | 0.30 |
| | 2.71 | | 0.98 | | 0.40 |
| | 3.15 | | 1.10 | | 0.24 |
| | 4.00 | | 1.05 | | 0.29 |
| | 3.30 | | 0.95 | | 0.27 |
| | 3.22 | | 0.96 | | 0.26 |

| Zone | Weight |
|---|---|
| 10 | 0.45 |
| | 0.24 |
| | 0.45 |
| | 0.32 |
| | 0.13 |
| | 0.30 |
| | 0.25 |
| | 0.14 |
| | 0.20 |
| | 0.14 |
| | 0.15 |
| | 0.13 |
| | 0.20 |
| | 0.20 |
| | 0.14 |
| | 0.10 |
| | 0.10 |
| | 0.13 |
| | 0.07 |
| | 0.05 |
| | 0.05 |
| | 0.10 |
| | 0.10 |
| | 0.09 |
| | 0.02 |
| | 0.08 |
| | 0.06 |
| | 0.05 |
| | 0.03 |
| | 0.03 |
| | 0.01 |
| | 0.07 |
| | 0.02 |
| Total | 1062.98 |
| 11 | 74.04 |
| | 55.68 |
| | 61.42 |
| | 71.00 |
| | 66.00 |
| | 73.06 |
| | 51.72 |
| | 55.00 |
| | 51.28 |
| | 64.24 |
| | 53.40 |
| | 43.90 |
| | 37.22 |
| | 37.00 |

| Zone | Weight |
|---|---|
| 11 | 37.62 |
| | 32.84 |
| | 33.00 |
| | 42.28 |
| | 38.40 |
| | 34.00 |
| | 43.12 |
| | 44.40 |
| | 34.00 |
| | 32.52 |
| | 35.80 |
| | 40.12 |
| | 34.00 |
| | 31.40 |
| | 29.24 |
| | 28.98 |
| | 26.70 |
| | 26.80 |
| | 26.30 |
| | 23.56 |
| | 26.64 |
| | 26.94 |
| | 27.40 |
| | 24.35 |
| | 26.07 |
| | 28.90 |
| | 22.14 |
| | 24.08 |
| | 24.50 |
| | 26.40 |
| | 19.60 |
| | 16.10 |
| | 23.90 |
| | 21.30 |
| | 21.87 |
| | 22.79 |
| | 23.70 |
| | 18.10 |
| | 17.39 |
| | 18.73 |
| | 18.65 |
| | 17.42 |
| | 22.65 |
| | 15.87 |
| | 15.25 |
| | 13.56 |
| | 16.45 |
| | 17.42 |
| | 16.65 |
| | 16.14 |

| Zone | Weight |
|---|---|
| 11 | 14.73 |
| | 13.05 |
| | 17.10 |
| | 15.00 |
| | 11.65 |
| | 15.50 |
| | 12.95 |
| | 13.34 |
| | 15.58 |
| | 16.54 |
| | 14.47 |
| | 15.32 |
| | 15.55 |
| | 11.39 |
| | 12.90 |
| | 15.93 |
| | 17.35 |
| | 12.60 |
| | 18.00 |
| | 12.66 |
| | 19.72 |
| | 15.94 |
| | 11.46 |
| | 16.49 |
| | 13.67 |
| | 13.68 |
| | 10.10 |
| | 11.95 |
| | 10.49 |
| | 15.21 |
| | 22.40 |
| | 14.77 |
| | 16.82 |
| | 13.10 |
| | 11.90 |
| | 12.32 |
| | 11.35 |
| | 13.55 |
| | 12.00 |
| | 13.06 |
| | 10.12 |
| | 12.64 |
| | 13.23 |
| | 12.17 |
| | 7.88 |
| | 9.89 |
| | 9.85 |
| | 9.74 |
| | 8.33 |
| | 9.50 |

| Zone | Weight | Zone | Weight | Zone | Weight |
|---|---|---|---|---|---|
| 11 | 7.78 | 11 | 5.22 | 11 | 3.35 |
| | 8.33 | | 4.32 | | 3.18 |
| | 10.15 | | 6.35 | | 3.96 |
| | 9.04 | | 6.09 | | 3.13 |
| | 8.52 | | 5.60 | | 3.59 |
| | 9.63 | | 4.93 | | 3.35 |
| | 10.43 | | 7.30 | | 3.12 |
| | 7.50 | | 6.32 | | 3.34 |
| | 9.63 | | 6.25 | | 3.18 |
| | 8.65 | | 4.90 | | 4.16 |
| | 8.88 | | 5.08 | | 2.78 |
| | 10.70 | | 5.21 | | 3.20 |
| | 8.04 | | 6.25 | | 2.60 |
| | 8.33 | | 5.47 | | 3.30 |
| | 6.60 | | 6.03 | | 2.40 |
| | 9.17 | | 4.85 | | 2.03 |
| | 8.67 | | 6.33 | | 3.36 |
| | 7.30 | | 5.83 | | 2.55 |
| | 9.60 | | 3.50 | | 3.80 |
| | 8.64 | | 5.37 | | 2.35 |
| | 9.40 | | 4.94 | | 2.80 |
| | 7.60 | | 4.98 | | 2.29 |
| | 8.00 | | 5.06 | | 2.60 |
| | 11.90 | | 4.12 | | 3.12 |
| | 7.04 | | 4.07 | | 2.35 |
| | 7.62 | | 5.09 | | 3.22 |
| | 6.66 | | 4.70 | | 3.37 |
| | 9.76 | | 5.05 | | 3.41 |
| | 8.50 | | 4.41 | | 2.26 |
| | 9.78 | | 3.60 | | 2.00 |
| | 11.00 | | 4.22 | | 2.25 |
| | 8.78 | | 4.36 | | 2.65 |
| | 6.83 | | 3.46 | | 2.65 |
| | 6.05 | | 5.24 | | 2.10 |
| | 6.36 | | 3.29 | | 1.86 |
| | 5.80 | | 4.67 | | 1.95 |
| | 6.87 | | 4.62 | | 1.94 |
| | 8.56 | | 4.34 | | 2.43 |
| | 7.97 | | 4.60 | | 2.09 |
| | 7.24 | | 4.72 | | 2.52 |
| | 6.30 | | 4.60 | | 2.66 |
| | 7.39 | | 4.30 | | 3.04 |
| | 6.80 | | 4.28 | | 2.64 |
| | 7.28 | | 3.51 | | 1.94 |
| | 7.12 | | 4.37 | | 2.35 |
| | 7.44 | | 4.14 | | 2.00 |
| | 5.25 | | 4.25 | | 2.54 |
| | 6.20 | | 4.25 | | 2.10 |
| | 6.84 | | 4.72 | | 2.00 |
| | 4.72 | | 4.28 | | 2.55 |

| Zone | Weight | Zone | Weight | Zone | Weight |
|---|---|---|---|---|---|
| 11 | 2.75 | 11 | 0.86 | 11 | 0.80 |
| | 2.00 | | 1.23 | | 0.64 |
| | 2.56 | | 1.45 | | 0.44 |
| | 1.70 | | 1.57 | | 0.44 |
| | 2.16 | | 0.90 | | 0.55 |
| | 2.46 | | 0.98 | | 0.52 |
| | 1.46 | | 1.30 | | 0.76 |
| | 2.37 | | 0.80 | | 0.60 |
| | 2.56 | | 1.18 | | 0.52 |
| | 2.20 | | 0.95 | | 0.50 |
| | 1.75 | | 1.25 | | 0.66 |
| | 1.59 | | 1.50 | | 0.40 |
| | 1.85 | | 1.24 | | 0.43 |
| | 1.76 | | 1.40 | | 0.65 |
| | 1.40 | | 1.05 | | 0.55 |
| | 2.36 | | 0.82 | | 0.66 |
| | 1.64 | | 1.06 | | 0.37 |
| | 1.60 | | 0.80 | | 0.52 |
| | 1.90 | | 0.90 | | 0.52 |
| | 2.15 | | 0.95 | | 0.55 |
| | 1.70 | | 0.75 | | 0.40 |
| | 1.85 | | 1.05 | | 0.55 |
| | 1.73 | | 0.88 | | 0.65 |
| | 2.11 | | 1.04 | | 0.56 |
| | 1.66 | | 0.80 | | 0.56 |
| | 1.81 | | 1.21 | | 0.45 |
| | 1.75 | | 0.85 | | 0.42 |
| | 1.80 | | 1.00 | | 0.38 |
| | 1.54 | | 1.18 | | 0.32 |
| | 1.78 | | 0.82 | | 0.51 |
| | 1.41 | | 0.85 | | 0.35 |
| | 1.53 | | 1.07 | | 0.25 |
| | 1.49 | | 0.84 | | 0.45 |
| | 1.40 | | 0.61 | | 0.24 |
| | 1.30 | | 0.67 | | 0.34 |
| | 1.25 | | 0.40 | | 0.28 |
| | 1.42 | | 0.70 | | 0.37 |
| | 1.35 | | 0.50 | | 0.30 |
| | 1.30 | | 0.40 | | 0.31 |
| | 1.60 | | 0.94 | | 0.30 |
| | 1.76 | | 0.65 | | 0.24 |
| | 1.42 | | 0.60 | | 0.21 |
| | 1.10 | | 0.77 | | 0.23 |
| | 2.20 | | 0.84 | | 0.18 |
| | 1.55 | | 0.95 | | 0.33 |
| | 1.70 | | 0.60 | | 0.21 |
| | 1.40 | | 0.58 | | 0.19 |
| | 1.41 | | 0.78 | | 0.27 |
| | 0.93 | | 0.65 | | 0.20 |
| | 1.15 | | 0.60 | | 0.25 |

| Zone | Weight |
|---|---|
| 11 | 0.19 |
| | 0.30 |
| | 0.30 |
| | 0.13 |
| | 0.15 |
| | 0.14 |
| | 0.15 |
| | 0.10 |
| | 0.21 |
| | 0.18 |
| | 0.12 |
| | 0.15 |
| | 0.16 |
| | 0.12 |
| | 0.12 |
| | 0.13 |
| | 0.12 |
| | 0.14 |
| | 0.10 |
| | 0.14 |
| | 0.10 |
| | 0.12 |
| | 0.08 |
| | 0.07 |
| | 0.07 |
| | 0.11 |
| | 0.08 |
| | 0.04 |
| | 0.08 |
| | 0.08 |
| | 0.11 |
| | 0.06 |
| | 0.09 |
| | 0.05 |
| | 0.06 |
| | 0.08 |
| | 0.05 |
| | 0.02 |
| | 0.03 |
| | 0.09 |
| | 0.06 |
| | 0.04 |
| | 0.05 |
| | 0.04 |
| | 0.05 |
| | 0.05 |
| | 0.02 |
| | 0.05 |
| | 0.07 |
| | 0.02 |

| Zone | Weight |
|---|---|
| 11 | 0.01 |
| | 0.05 |
| | 0.06 |
| | 0.02 |
| | 0.02 |
| | 0.02 |
| | 0.05 |
| | 0.05 |
| | 0.05 |
| | 0.05 |
| | 0.05 |
| | 0.05 |
| | 0.05 |
| | 0.05 |
| | 0.05 |
| | 0.01 |
| | 0.01 |
| | 0.01 |
| | 0.01 |
| | 0.01 |
| | 0.01 |
| | 0.01 |
| Total | 3718.05 |
| 12 | 8.72 |
| | 7.56 |
| | 6.72 |
| | 9.60 |
| | 6.53 |
| | 5.21 |
| | 5.30 |
| | 5.02 |
| | 3.35 |
| | 3.86 |
| | 4.35 |
| | 2.65 |
| | 2.61 |
| | 3.91 |
| | 2.30 |
| | 2.23 |
| | 2.36 |
| | 2.40 |
| | 2.72 |
| | 1.69 |
| | 2.15 |
| | 2.59 |

| Zone | Weight |
|---|---|
| 12 | 1.24 |
| | 1.78 |
| | 1.29 |
| | 1.44 |
| | 1.08 |
| | 0.83 |
| | 0.75 |
| | 0.75 |
| | 0.42 |
| | 0.76 |
| | 0.83 |
| | 0.80 |
| | 0.64 |
| | 0.34 |
| | 0.34 |
| | 0.40 |
| | 0.07 |
| Total | 107.59 |
| 13 | 34.00 |
| | 29.32 |
| | 19.25 |
| | 16.05 |
| | 19.66 |
| | 13.25 |
| | 13.05 |
| | 12.44 |
| | 9.35 |
| | 9.47 |
| | 8.05 |
| | 7.02 |
| | 6.60 |
| | 8.15 |
| | 8.57 |
| | 6.22 |
| | 6.70 |
| | 7.28 |
| | 6.45 |
| | 7.78 |
| | 5.00 |
| | 8.10 |
| | 5.66 |
| | 5.42 |
| | 4.25 |
| | 3.66 |
| | 3.60 |
| | 4.27 |
| | 4.28 |
| | 3.28 |

| Zone | Weight |
|---|---|
| 13 | 2.34 |
| | 3.38 |
| | 3.85 |
| | 3.28 |
| | 4.17 |
| | 2.82 |
| | 3.06 |
| | 2.50 |
| | 2.00 |
| | 1.73 |
| | 1.64 |
| | 3.00 |
| | 1.74 |
| | 1.00 |
| | 1.28 |
| | 1.55 |
| | 1.12 |
| | 1.30 |
| | 1.11 |
| | 0.80 |
| | 1.16 |
| | 1.00 |
| | 0.80 |
| | 1.10 |
| | 1.50 |
| | 0.66 |
| | 0.88 |
| | 0.75 |
| | 0.64 |
| | 0.85 |
| | 0.80 |
| | 0.42 |
| | 0.47 |
| | 0.52 |
| | 0.40 |
| | 0.60 |
| | 0.32 |
| | 0.27 |
| | 0.30 |
| | 0.41 |
| | 0.22 |
| | 0.13 |
| | 0.15 |
| | 0.16 |
| | 0.30 |
| | 0.13 |
| | 0.11 |
| | 0.11 |

| Zone | Weight |
|---|---|
| 13 | 0.04 |
| | 0.04 |
| Total | 355.09 |
| 14 | 13.76 |
| | 13.12 |
| | 7.81 |
| | 7.23 |
| | 4.00 |
| | 4.22 |
| | 4.40 |
| | 4.10 |
| | 3.40 |
| | 1.93 |
| | 2.25 |
| | 1.70 |
| | 1.37 |
| | 0.74 |
| | 0.79 |
| | 0.69 |
| | 0.88 |
| | 0.60 |
| | 0.63 |
| | 0.33 |
| | 0.30 |
| | 0.34 |
| | 0.37 |
| | 0.40 |
| | 0.29 |
| | 0.24 |
| | 0.25 |
| | 0.14 |
| Total | 76.28 |
| 15 | 3.90 |
| | 1.70 |
| | 1.30 |
| | 1.45 |
| | 1.37 |
| | 1.06 |
| | 1.34 |
| | 1.46 |
| | 0.72 |
| Total | 14.30 |

| Zone | Weight |
|---|---|
| 16 | 8.29 |
| | 9.40 |
| | 6.60 |
| | 4.89 |
| | 1.80 |
| | 1.34 |
| | 0.90 |
| | 0.76 |
| | 0.64 |
| | 0.41 |
| | 0.50 |
| | 0.44 |
| | 0.23 |
| Total | 36.20 |
| 17 | 34.00 |
| | 32.42 |
| | 24.93 |
| | 18.30 |
| | 18.15 |
| | 9.80 |
| | 13.23 |
| | 11.00 |
| | 8.98 |
| | 8.62 |
| | 7.89 |
| | 7.15 |
| | 6.65 |
| | 5.38 |
| | 4.05 |
| | 4.35 |
| | 3.60 |
| | 3.89 |
| | 2.72 |
| | 1.70 |
| | 1.87 |
| | 2.20 |
| | 3.10 |
| | 2.36 |
| | 3.12 |
| | 1.59 |
| | 1.35 |
| | 1.64 |
| | 1.96 |
| | 1.30 |
| | 1.85 |
| | 1.50 |

| Zone | Weight |
|---|---|
| 17 | 1.29 |
| | 1.82 |
| | 1.51 |
| | 1.23 |
| | 1.40 |
| | 1.12 |
| | 1.00 |
| | 1.14 |
| | 0.82 |
| | 0.91 |
| | 0.87 |
| | 1.21 |
| | 0.70 |
| | 0.78 |
| | 1.19 |
| | 0.60 |
| | 0.65 |
| | 0.70 |
| | 0.68 |
| | 0.56 |
| | 0.60 |
| | 0.75 |
| | 0.67 |
| | 0.55 |
| | 0.62 |
| | 0.44 |
| | 0.48 |
| | 0.70 |
| | 0.54 |
| | 0.49 |
| | 0.73 |
| | 0.48 |
| | 0.39 |
| | 0.36 |
| | 0.27 |
| | 0.59 |
| | 0.55 |
| | 0.40 |
| | 0.40 |
| | 0.29 |
| | 0.50 |
| | 0.35 |
| | 0.48 |
| | 0.39 |
| | 0.38 |
| | 0.44 |
| | 0.40 |
| | 0.40 |
| | 0.43 |
| | 0.25 |

| Zone | Weight |
|---|---|
| 17 | 0.40 |
| | 0.33 |
| | 0.35 |
| | 0.42 |
| | 0.31 |
| | 0.26 |
| | 0.22 |
| | 0.20 |
| | 0.19 |
| | 0.20 |
| | 0.18 |
| | 0.23 |
| | 0.20 |
| | 0.20 |
| | 0.14 |
| | 0.30 |
| | 0.14 |
| | 0.30 |
| | 0.26 |
| | 0.16 |
| | 0.13 |
| | 0.12 |
| | 0.19 |
| | 0.15 |
| | 0.23 |
| | 0.14 |
| | 0.20 |
| | 0.10 |
| | 0.16 |
| | 0.16 |
| | 0.07 |
| | 0.15 |
| | 0.10 |
| | 0.08 |
| | 0.10 |
| | 0.09 |
| | 0.09 |
| | 0.05 |
| | 0.05 |
| | 0.02 |
| Total | 292.52 |
| 18 | 19.05 |
| | 23.00 |
| | 16.60 |
| | 13.38 |
| | 14.10 |
| | 11.69 |
| | 12.92 |

| Zone | Weight |
|---|---|
| 18 | 13.66 |
| | 14.90 |
| | 12.52 |
| | 8.59 |
| | 10.97 |
| | 8.79 |
| | 10.78 |
| | 6.08 |
| | 5.92 |
| | 6.05 |
| | 5.41 |
| | 5.93 |
| | 5.52 |
| | 3.78 |
| | 4.70 |
| | 5.21 |
| | 5.37 |
| | 4.20 |
| | 4.05 |
| | 4.83 |
| | 4.39 |
| | 5.14 |
| | 3.36 |
| | 4.30 |
| | 2.80 |
| | 3.74 |
| | 3.20 |
| | 2.70 |
| | 3.52 |
| | 2.59 |
| | 2.40 |
| | 3.38 |
| | 2.92 |
| | 2.75 |
| | 2.13 |
| | 2.51 |
| | 3.16 |
| | 3.10 |
| | 3.35 |
| | 2.41 |
| | 2.85 |
| | 1.60 |
| | 2.69 |
| | 2.42 |
| | 2.30 |
| | 2.12 |
| | 1.80 |
| | 2.37 |
| | 2.43 |
| | 2.13 |

| Zone | Weight | Zone | Weight | Zone | Weight | Code |
|---|---|---|---|---|---|---|
| 18 | 1.80 | 18 | 0.88 | 18 | 0.34 | |
| | 1.56 | | 0.91 | | 0.30 | |
| | 1.50 | | 0.80 | | 0.26 | |
| | 2.00 | | 0.95 | | 0.29 | |
| | 2.31 | | 0.92 | | 0.22 | |
| | 1.84 | | 0.95 | | 0.25 | |
| | 1.66 | | 0.95 | | 0.34 | |
| | 1.49 | | 0.70 | | 0.27 | |
| | 1.98 | | 0.96 | | 0.35 | |
| | 1.86 | | 0.70 | | 0.25 | |
| | 1.48 | | 0.94 | | 0.20 | |
| | 2.17 | | 0.60 | | 0.43 | B |
| | 1.79 | | 0.58 | | 0.35 | B |
| | 2.10 | | 0.82 | | 0.55 | B |
| | 2.08 | | 0.62 | | 0.37 | B |
| | 1.82 | | 0.78 | | 0.15 | |
| | 1.30 | | 0.86 | | 0.30 | |
| | 1.85 | | 0.77 | | 0.30 | |
| | 1.26 | | 0.50 | | 0.27 | |
| | 1.92 | | 0.68 | | 0.20 | |
| | 1.22 | | 0.54 | | 0.24 | |
| | 1.42 | | 0.52 | | 0.24 | |
| | 1.45 | | 0.54 | | 0.30 | |
| | 2.06 | | 0.50 | | 0.20 | |
| | 1.26 | | 0.47 | | 0.23 | |
| | 1.49 | | 0.35 | | 0.25 | |
| | 1.22 | | 0.54 | | 0.24 | |
| | 1.18 | | 0.50 | | 0.22 | |
| | 0.95 | | 0.54 | | 0.22 | |
| | 1.20 | | 0.45 | | 0.25 | |
| | 1.00 | | 0.53 | | 0.24 | |
| | 1.20 | | 0.42 | | 0.16 | |
| | 1.09 | | 0.45 | | 0.15 | |
| | 1.08 | | 0.38 | | 0.19 | |
| | 1.30 | | 0.50 | | 0.16 | |
| | 0.94 | | 0.50 | | 0.16 | |
| | 0.78 | | 0.35 | | 0.18 | |
| | 0.72 | | 0.47 | | 0.17 | |
| | 0.82 | | 0.42 | | 0.26 | |
| | 0.92 | | 0.40 | | 0.14 | |
| | 0.82 | | 0.55 | | 0.19 | |
| | 0.82 | | 0.40 | | 0.14 | |
| | 1.05 | | 0.42 | | 0.13 | |
| | 0.85 | | 0.31 | | 0.16 | |
| | 1.63 | | 0.46 | | 0.09 | |
| | 1.05 | | 0.50 | | 0.10 | |
| | 1.07 | | 0.37 | | 0.13 | |
| | 1.22 | | 0.38 | | 0.15 | |
| | 0.73 | | 0.38 | | 0.10 | |
| | 0.74 | | 0.34 | | 0.10 | |

| Zone | Weight | Zone | Weight | Code | Zone | Weight | Code |
|---|---|---|---|---|---|---|---|
| 18 | 0.09 | 18 | 0.01 | | 19 | 1.80 | |
| | 0.10 | | 0.01 | | | 1.72 | B |
| | 0.10 | | | | | 1.70 | B |
| | 0.05 | Total | 456.77 | | | 1.65 | B |
| | 0.07 | | | | | 2.00 | B |
| | 0.10 | 19 | 249.00 | B | | 1.40 | |
| | 0.05 | | 37.80 | B | | 1.26 | B |
| | 0.06 | | 26.75 | B | | 1.30 | |
| | 0.05 | | 27.33 | B | | 1.75 | |
| | 0.11 | | 15.80 | | | 1.34 | B |
| | 0.05 | | 14.85 | B | | 1.42 | B |
| | 0.07 | | 11.37 | B | | 1.50 | B |
| | 0.05 | | 10.40 | | | 1.25 | B |
| | 0.07 | | 12.42 | B | | 1.25 | B |
| | 0.07 | | 12.75 | B | | 1.34 | |
| | 0.05 | | 9.32 | B | | 1.10 | |
| | 0.09 | | 7.57 | | | 1.20 | |
| | 0.05 | | 7.29 | B | | 0.80 | |
| | 0.04 | | 8.10 | B | | 1.10 | B |
| | 0.09 | | 7.64 | | | 0.80 | B |
| | 0.04 | | 6.55 | B | | 0.75 | |
| | 0.04 | | 5.43 | B | | 0.87 | B |
| | 0.04 | | 5.22 | B | | 0.67 | B |
| | 0.05 | | 4.28 | B | | 0.45 | |
| | 0.04 | | 4.18 | | | 0.68 | B |
| | 0.05 | | 4.44 | | | 0.64 | B |
| | 0.05 | | 3.75 | B | | 0.80 | B |
| | 0.06 | | 3.70 | | | 0.68 | B |
| | 0.05 | | 3.88 | | | 0.72 | |
| | 0.05 | | 3.32 | | | 0.53 | B |
| | 0.03 | | 3.00 | | | 0.54 | |
| | 0.03 | | 2.97 | B | | 0.54 | |
| | 0.03 | | 3.20 | B | | 0.44 | |
| | 0.05 | | 4.42 | B | | 0.36 | |
| | 0.02 | | 2.80 | B | | 0.57 | B |
| | 0.03 | | 3.15 | B | | 0.47 | B |
| | 0.02 | | 2.75 | | | 0.51 | B |
| | 0.02 | | 2.40 | B | | 0.47 | B |
| | 0.02 | | 2.22 | B | | 0.40 | B |
| | 0.02 | | 1.83 | | | 0.37 | B |
| | 0.02 | | 2.50 | B | | 0.36 | |
| | 0.02 | | 2.46 | B | | 0.52 | B |
| | 0.02 | | 2.50 | B | | 0.44 | B |
| | 0.02 | | 2.62 | | | 0.50 | B |
| | 0.02 | | 2.04 | B | | 0.38 | B |
| | 0.02 | | 2.02 | | | 0.60 | B |
| | 0.01 | | 1.95 | B | | 0.33 | B |
| | 0.01 | | 1.88 | | | 0.32 | |
| | 0.01 | | 1.75 | | | 0.36 | B |
| | 0.01 | | 1.97 | B | | 0.40 | B |

| Zone | Weight | Code | Zone | Weight | Grain | Zone | Weight | Code |
|---|---|---|---|---|---|---|---|---|
| 19 | 0.41 | B | 19 | 0.22 | B | 19B | 2.65 | |
| | 0.40 | B | | 0.10 | B | | 2.58 | B |
| | 0.55 | B | | 0.10 | B | | 2.00 | |
| | 0.40 | B | | 0.08 | B | | 1.44 | |
| | 0.45 | B | | 0.13 | B | | 1.63 | B |
| | 0.35 | B | | 0.10 | B | | 1.45 | B |
| | 0.32 | B | | 0.10 | B | | 1.30 | |
| | 0.42 | B | | 0.09 | B | | 1.40 | B |
| | 0.40 | | | 0.09 | B | | 1.22 | B |
| | 0.26 | | | 0.07 | B | | 1.10 | |
| | 0.37 | B | | 0.10 | B | | 1.40 | |
| | 0.39 | B | | 0.10 | B | | 1.22 | |
| | 0.40 | B | | 0.07 | B | | 0.72 | |
| | 0.30 | B | | 0.10 | | | 0.80 | |
| | 0.34 | B | | 0.06 | | | 0.75 | |
| | 0.30 | B | | 0.07 | | | 0.57 | B |
| | 0.28 | B | | 0.05 | | | 0.75 | B |
| | 0.21 | B | | 0.06 | | | 0.52 | B |
| | 0.23 | | | 0.05 | | | 0.47 | |
| | 0.30 | | | 0.06 | B | | 0.43 | |
| | 0.18 | | | 0.05 | B | | 0.33 | |
| | 0.27 | B | | 0.04 | B | | 0.44 | B |
| | 0.26 | B | | 0.02 | B | | 0.36 | |
| | 0.23 | B | | 0.07 | B | | 0.30 | |
| | 0.12 | B | | 0.05 | B | | 0.25 | |
| | 0.36 | | | 0.04 | B | | 0.24 | |
| | 0.24 | | | 0.04 | B | | 0.25 | |
| | 0.18 | | | 0.03 | B | | 0.20 | |
| | 0.15 | | | 0.05 | B | | 0.25 | |
| | 0.17 | B | | 0.05 | B | | 0.16 | |
| | 0.25 | B | | 0.02 | B | | 0.26 | B |
| | 0.17 | B | | 0.02 | B | | 0.27 | B |
| | 0.19 | B | | 0.02 | | | 0.24 | B |
| | 0.21 | B | | 0.02 | | | 0.29 | B |
| | 0.25 | B | | 0.02 | | | 0.24 | B |
| | 0.24 | B | | | | | 0.20 | B |
| | 0.20 | B | Total | 611.97 | | | 0.23 | B |
| | 0.19 | B | | | | | 0.17 | B |
| | 0.18 | B | 19B | 28.77 | B | | 0.22 | B |
| | 0.17 | | | 17.73 | | | 0.25 | B |
| | 0.14 | | | 8.55 | B | | 0.22 | B |
| | 0.21 | | | 4.60 | | | 0.24 | B |
| | 0.15 | B | | 6.27 | | | 0.19 | B |
| | 0.18 | B | | 3.60 | | | 0.21 | B |
| | 0.15 | B | | 3.45 | B | | 0.19 | B |
| | 0.12 | B | | 2.94 | | | 0.19 | B |
| | 0.12 | | | 3.28 | | | 0.12 | B |
| | 0.15 | | | 2.86 | | | 0.14 | |
| | 0.10 | | | 2.64 | | | 0.20 | |
| | 0.10 | | | 3.02 | | | 0.19 | |

| Zone | Weight | Code |
|---|---|---|
| 19B | 0.14 | |
| | 0.16 | |
| | 0.14 | |
| | 0.13 | |
| | 0.13 | B |
| | 0.17 | B |
| | 0.18 | B |
| | 0.12 | B |
| | 0.10 | B |
| | 0.10 | |
| | 0.08 | |
| | 0.07 | |
| | 0.02 | |
| | 0.02 | |
| | 0.10 | B |
| | 0.08 | B |
| | 0.07 | B |
| | 0.09 | B |
| | 0.06 | B |
| | 0.05 | B |
| | 0.05 | B |
| | 0.05 | B |
| | 0.06 | B |
| | 0.05 | B |
| | 0.08 | B |
| | 0.05 | B |
| | 0.06 | B |
| | 0.03 | B |
| | 0.05 | B |
| | 0.05 | B |
| | 0.03 | B |
| | 0.05 | B |
| | 0.02 | B |
| | 0.02 | B |
| | 0.02 | B |
| | 0.02 | B |
| | 0.02 | B |
| | 0.02 | B |
| Total | 121.89 | |
| 18B | 6.87 | |
| | 4.03 | |
| | 4.15 | |
| | 5.62 | |
| | 3.63 | |
| | 2.85 | |
| | 2.27 | |
| | 2.45 | |
| | 2.80 | |

| Zone | Weight | Code |
|---|---|---|
| 18B | 2.37 | |
| | 2.23 | |
| | 1.52 | |
| | 1.40 | |
| | 1.26 | |
| | 1.42 | |
| | 1.45 | B |
| | 1.51 | B |
| | 1.69 | |
| | 1.36 | |
| | 0.04 | |
| | 0.05 | |
| | 0.04 | |
| | 0.95 | |
| | 0.92 | |
| | 1.06 | |
| | 0.67 | |
| | 0.82 | |
| | 0.72 | B |
| | 0.47 | B |
| | 0.45 | B |
| | 0.50 | B |
| | 0.41 | B |
| | 0.33 | |
| | 0.49 | |
| | 0.30 | |
| | 0.25 | |
| | 0.23 | |
| | 0.25 | |
| | 0.39 | |
| | 0.35 | |
| | 0.22 | |
| | 0.33 | |
| | 0.30 | |
| | 0.29 | |
| | 0.18 | |
| | 0.11 | |
| | 0.15 | |
| | 0.20 | B |
| | 0.15 | |
| | 0.09 | |
| | 0.06 | |
| | 0.05 | |
| | 0.11 | B |
| | 0.03 | B |
| Total | 62.84 | |
| 1N | 93.42 | F |
| | 11.79 | F |

| Zone | Weight | Code |
|---|---|---|
| 1N | 5.24 | F |
| | 1.58 | F |
| | 1.27 | F |
| Total | 113.30 | |
| 2N | 118.00 | F |
| | 19.72 | F |
| | 6.95 | F |
| Total | 144.67 | |

GRAND TOTAL

No. 1833

Weight Grains 14,593.25

Code:

F - Fuze
B - Brass
NR - No Recovery

115-mm, XM378
Round No. 3
20 November 1959

| Zone | Weight | Code |
|---|---|---|
| 1N | 5761.00 | F |
| | 24.20 | F |
| | 21.64 | F |
| | 15.07 | F |
| | 10.13 | F |
| | 2.09 | F |
| | 1.53 | F |
| | 1.45 | F |
| | 1.15 | F |
| | 1.05 | F |
| | 0.89 | F |
| | 0.82 | F |
| | 0.55 | F |
| | 0.55 | F |
| | 0.54 | F |
| | 0.22 | F |
| | 0.13 | F |
| | 0.02 | F |
| Total | 5843.03 | |
| 2N | 62.82 | F |
| | 10.13 | F |
| | 5.73 | F |
| | 4.70 | F |
| | 0.80 | F |
| | 0.40 | F |
| | 0.24 | F |
| Total | 84.82 | |
| 1 | 24.72 | F |
| | 5.42 | F |
| | 4.72 | F |
| | 4.40 | F |
| | 3.67 | F |
| | 2.40 | F |
| | 1.98 | F |
| | 1.50 | F |
| | 1.30 | F |
| | 1.09 | F |
| | 1.03 | F |
| | 0.58 | F |
| | 0.38 | F |
| | 0.31 | F |
| | 0.23 | F |
| | 0.22 | F |
| 1 | 0.15 | F |
| | 0.13 | F |
| | 0.10 | F |
| | 0.09 | F |
| Total | 54.42 | |
| 2 | 835.00 | F |
| | 267.00 | F |
| | 103.00 | F |
| | 25.76 | F |
| | 21.45 | F |
| | 15.90 | F |
| | 8.70 | F |
| | 3.30 | F |
| | 2.26 | F |
| Total | 1282.37 | |
| 3 | 54.50 | F |
| | 38.32 | F |
| | 4.85 | F |
| Total | 97.67 | |
| 4 | NR | |
| 5 | 2.41 | |
| | 2.11 | |
| | 0.72 | |
| | 0.60 | |
| Total | 5.84 | |
| 6 | 10.80 | |
| | 5.18 | |
| | 2.53 | |
| | 0.60 | |
| | 0.42 | |
| | 0.28 | |
| Total | 19.81 | |
| 7 | 1.80 | |
| | 1.69 | |
| | 0.60 | |
| | 0.59 | |
| 7 | 0.20 | |
| Total | 4.88 | |
| 8 | 24.16 | |
| | 4.47 | |
| | 4.37 | |
| | 3.46 | |
| | 2.21 | |
| | 1.92 | |
| | 1.89 | |
| | 1.70 | |
| | 1.65 | |
| | 1.62 | |
| | 1.35 | |
| | 1.09 | |
| | 0.92 | |
| | 0.90 | |
| | 0.90 | |
| | 0.90 | |
| | 0.77 | |
| | 0.74 | |
| | 0.64 | |
| | 0.60 | |
| | 0.54 | |
| | 0.52 | |
| | 0.40 | |
| | 0.35 | |
| | 0.18 | |
| | 0.14 | |
| | 0.12 | |
| | 0.12 | |
| | 0.10 | |
| | 0.09 | |
| | 0.05 | |
| | 0.03 | |
| Total | 58.90 | |
| 9 | 19.12 | |
| | 17.36 | |
| | 14.10 | |
| | 13.29 | |
| | 10.67 | |
| | 9.98 | |
| | 9.80 | |
| | 7.43 | |

| Zone | Weight | Zone | Weight | Zone | Weight |
|---|---|---|---|---|---|
| 9 | 6.46 | 9 | 0.64 | 10 | 13.13 |
| | 6.28 | | 0.62 | | 13.11 |
| | 6.22 | | 0.54 | | 12.60 |
| | 6.20 | | 0.50 | | 12.31 |
| | 6.15 | | 0.44 | | 12.30 |
| | 6.10 | | 0.43 | | 12.13 |
| | 5.40 | | 0.40 | | 11.95 |
| | 5.39 | | 0.37 | | 11.49 |
| | 5.30 | | 0.35 | | 10.82 |
| | 4.91 | | 0.34 | | 10.60 |
| | 4.90 | | 0.30 | | 9.30 |
| | 4.62 | | 0.28 | | 9.18 |
| | 3.82 | | 0.25 | | 9.00 |
| | 3.49 | | 0.24 | | 9.00 |
| | 3.37 | | 0.23 | | 8.95 |
| | 3.37 | | 0.22 | | 8.66 |
| | 3.08 | | 0.21 | | 8.28 |
| | 3.04 | | 0.19 | | 8.22 |
| | 2.95 | | 0.18 | | 8.15 |
| | 2.95 | | 0.18 | | 7.92 |
| | 2.92 | | 0.11 | | 7.83 |
| | 2.82 | | 0.11 | | 7.82 |
| | 2.80 | | 0.11 | | 7.57 |
| | 2.80 | | 0.11 | | 7.55 |
| | 2.72 | | 0.10 | | 7.38 |
| | 2.35 | | 0.10 | | 7.30 |
| | 2.30 | | 0.09 | | 7.02 |
| | 2.30 | | 0.08 | | 6.80 |
| | 2.27 | | 0.07 | | 6.52 |
| | 2.00 | | 0.04 | | 6.45 |
| | 1.85 | | 0.04 | | 6.45 |
| | 1.53 | | 0.03 | | 6.05 |
| | 1.48 | | 0.02 | | 5.98 |
| | 1.38 | | 0.02 | | 5.68 |
| | 1.12 | | | | 5.63 |
| | 1.08 | Total | 248.54 | | 5.60 |
| | 0.97 | | | | 5.20 |
| | 0.96 | 10 | 22.06 | | 5.18 |
| | 0.94 | | 20.70 | | 5.15 |
| | 0.93 | | 19.41 | | 5.03 |
| | 0.85 | | 19.25 | | 5.00 |
| | 0.80 | | 17.59 | | 4.95 |
| | 0.80 | | 15.85 | | 4.92 |
| | 0.80 | | 15.55 | | 4.87 |
| | 0.76 | | 15.19 | | 4.77 |
| | 0.68 | | 15.03 | | 4.72 |
| | 0.68 | | 14.80 | | 4.66 |
| | 0.67 | | 14.26 | | 4.46 |
| | 0.65 | | 13.60 | | 4.46 |
| | 0.64 | | 13.35 | | 4.41 |

| Zone | Weight | Zone | Weight | Zone | Weight |
|---|---|---|---|---|---|
| 10 | 4.17 | 10 | 1.96 | 10 | 0.95 |
| | 4.12 | | 1.94 | | 0.94 |
| | 3.98 | | 1.93 | | 0.91 |
| | 3.79 | | 1.90 | | 0.89 |
| | 3.74 | | 1.90 | | 0.89 |
| | 3.66 | | 1.90 | | 0.89 |
| | 3.63 | | 1.86 | | 0.88 |
| | 3.60 | | 1.84 | | 0.87 |
| | 3.60 | | 1.79 | | 0.87 |
| | 3.59 | | 1.77 | | 0.85 |
| | 3.55 | | 1.72 | | 0.85 |
| | 3.54 | | 1.70 | | 0.84 |
| | 3.52 | | 1.69 | | 0.82 |
| | 3.52 | | 1.64 | | 0.80 |
| | 3.46 | | 1.60 | | 0.79 |
| | 3.37 | | 1.60 | | 0.76 |
| | 3.25 | | 1.54 | | 0.75 |
| | 3.15 | | 1.48 | | 0.75 |
| | 3.14 | | 1.46 | | 0.73 |
| | 3.12 | | 1.46 | | 0.72 |
| | 3.11 | | 1.45 | | 0.72 |
| | 3.10 | | 1.45 | | 0.72 |
| | 3.06 | | 1.40 | | 0.69 |
| | 3.04 | | 1.39 | | 0.68 |
| | 3.03 | | 1.32 | | 0.68 |
| | 2.96 | | 1.31 | | 0.65 |
| | 2.92 | | 1.30 | | 0.65 |
| | 2.90 | | 1.26 | | 0.63 |
| | 2.89 | | 1.26 | | 0.62 |
| | 2.80 | | 1.25 | | 0.62 |
| | 2.75 | | 1.20 | | 0.62 |
| | 2.70 | | 1.18 | | 0.60 |
| | 2.70 | | 1.12 | | 0.60 |
| | 2.67 | | 1.10 | | 0.58 |
| | 2.66 | | 1.10 | | 0.58 |
| | 2.62 | | 1.10 | | 0.54 |
| | 2.61 | | 1.09 | | 0.54 |
| | 2.57 | | 1.06 | | 0.53 |
| | 2.46 | | 1.06 | | 0.52 |
| | 2.42 | | 1.05 | | 0.51 |
| | 2.42 | | 1.04 | | 0.50 |
| | 2.36 | | 1.02 | | 0.50 |
| | 2.30 | | 1.01 | | 0.48 |
| | 2.30 | | 1.73 | | 0.48 |
| | 2.21 | | 1.33 | | 0.45 |
| | 2.17 | | 1.05 | | 0.45 |
| | 2.16 | | 0.98 | | 0.44 |
| | 2.15 | | 0.98 | | 0.43 |
| | 2.02 | | 0.96 | | 0.42 |
| | 2.00 | | 0.95 | | 0.42 |

| Zone | Weight | Zone | Weight | Zone | Weight |
|---|---|---|---|---|---|
| 10 | 0.40 | 10 | 0.14 | 11 | 89.62 |
| | 0.40 | | 0.14 | | 81.62 |
| | 0.40 | | 0.14 | | 75.20 |
| | 0.40 | | 0.13 | | 73.20 |
| | 0.40 | | 0.13 | | 61.88 |
| | 0.38 | | 0.13 | | 59.20 |
| | 0.38 | | 0.13 | | 58.20 |
| | 0.36 | | 0.12 | | 57.60 |
| | 0.35 | | 0.12 | | 54.62 |
| | 0.34 | | 0.11 | | 52.80 |
| | 0.34 | | 0.11 | | 52.78 |
| | 0.34 | | 0.10 | | 52.20 |
| | 0.34 | | 0.10 | | 48.26 |
| | 0.31 | | 0.10 | | 47.42 |
| | 0.30 | | 0.10 | | 44.20 |
| | 0.30 | | 0.10 | | 43.40 |
| | 0.29 | | 0.10 | | 40.72 |
| | 0.29 | | 0.09 | | 39.44 |
| | 0.29 | | 0.09 | | 39.00 |
| | 0.28 | | 0.09 | | 39.00 |
| | 0.28 | | 0.08 | | 36.60 |
| | 0.27 | | 0.08 | | 32.80 |
| | 0.25 | | 0.08 | | 32.20 |
| | 0.25 | | 0.08 | | 31.92 |
| | 0.25 | | 0.07 | | 31.80 |
| | 0.25 | | 0.06 | | 30.32 |
| | 0.24 | | 0.06 | | 29.49 |
| | 0.24 | | 0.06 | | 27.87 |
| | 0.24 | | 0.06 | | 27.75 |
| | 0.23 | | 0.05 | | 27.70 |
| | 0.22 | | 0.05 | | 27.43 |
| | 0.22 | | 0.05 | | 26.82 |
| | 0.22 | | 0.05 | | 26.15 |
| | 0.21 | | 0.05 | | 26.00 |
| | 0.20 | | 0.04 | | 25.99 |
| | 0.20 | | 0.04 | | 25.68 |
| | 0.19 | | 0.04 | | 25.62 |
| | 0.19 | | 0.04 | | 24.42 |
| | 0.18 | | 0.04 | | 24.25 |
| | 0.17 | | 0.04 | | 23.80 |
| | 0.17 | | 0.03 | | 23.31 |
| | 0.17 | | 0.03 | | 23.15 |
| | 0.17 | | 0.03 | | 22.78 |
| | 0.17 | | 0.03 | | 22.50 |
| | 0.16 | | 0.03 | | 21.62 |
| | 0.16 | | 0.02 | | 21.54 |
| | 0.15 | | 0.02 | | 21.49 |
| | 0.15 | | 0.01 | | 21.10 |
| | 0.15 | | 0.01 | | 20.00 |
| | 0.14 | | | | 19.98 |
| | 0.14 | Total | 869.21 | | 19.30 |

| Zone | Weight | Zone | Weight | Zone | Weight |
|---|---|---|---|---|---|
| 11 | 18.97 | 11 | 10.65 | 11 | 6.67 |
| | 18.50 | | 10.62 | | 6.65 |
| | 18.22 | | 10.57 | | 6.64 |
| | 18.12 | | 10.52 | | 6.59 |
| | 17.85 | | 10.50 | | 6.54 |
| | 17.60 | | 10.47 | | 6.45 |
| | 17.46 | | 10.42 | | 6.33 |
| | 17.34 | | 10.40 | | 6.33 |
| | 17.29 | | 10.32 | | 6.32 |
| | 17.28 | | 10.22 | | 6.16 |
| | 16.60 | | 10.20 | | 6.13 |
| | 16.60 | | 10.13 | | 6.08 |
| | 16.58 | | 10.08 | | 6.02 |
| | 16.50 | | 9.88 | | 6.00 |
| | 16.46 | | 9.75 | | 5.92 |
| | 16.45 | | 9.56 | | 5.90 |
| | 16.45 | | 9.50 | | 5.83 |
| | 16.10 | | 9.49 | | 5.82 |
| | 15.70 | | 9.38 | | 5.76 |
| | 15.48 | | 9.25 | | 5.70 |
| | 15.15 | | 9.25 | | 5.70 |
| | 15.10 | | 9.20 | | 5.68 |
| | 14.77 | | 9.18 | | 5.65 |
| | 14.70 | | 8.89 | | 5.63 |
| | 14.38 | | 8.80 | | 5.61 |
| | 14.32 | | 8.75 | | 5.54 |
| | 14.20 | | 8.65 | | 5.47 |
| | 14.06 | | 8.65 | | 5.42 |
| | 13.87 | | 8.52 | | 5.42 |
| | 13.71 | | 8.34 | | 5.38 |
| | 13.70 | | 8.23 | | 5.32 |
| | 13.44 | | 7.43 | | 5.23 |
| | 13.31 | | 7.32 | | 5.22 |
| | 13.03 | | 7.25 | | 5.22 |
| | 13.00 | | 7.22 | | 5.22 |
| | 12.70 | | 7.20 | | 5.20 |
| | 12.44 | | 7.20 | | 5.14 |
| | 12.17 | | 7.10 | | 5.12 |
| | 11.97 | | 7.10 | | 5.10 |
| | 11.82 | | 7.06 | | 5.06 |
| | 11.63 | | 7.00 | | 5.06 |
| | 11.61 | | 6.93 | | 5.00 |
| | 11.46 | | 6.92 | | 4.98 |
| | 11.08 | | 6.85 | | 4.95 |
| | 11.08 | | 6.84 | | 4.87 |
| | 10.95 | | 6.83 | | 4.87 |
| | 10.81 | | 6.79 | | 4.82 |
| | 10.79 | | 6.79 | | 4.80 |
| | 10.72 | | 6.75 | | 4.80 |
| | 10.70 | | 6.75 | | 4.80 |

| Zone | Weight | Zone | Weight | Zone | Weight |
|---|---|---|---|---|---|
| 11 | 4.74 | 11 | 3.36 | 11 | 2.15 |
| | 4.70 | | 3.32 | | 2.10 |
| | 4.70 | | 3.28 | | 2.10 |
| | 4.67 | | 3.24 | | 2.07 |
| | 4.63 | | 3.22 | | 2.06 |
| | 4.57 | | 3.20 | | 2.05 |
| | 4.55 | | 3.15 | | 2.02 |
| | 4.55 | | 3.14 | | 2.00 |
| | 4.50 | | 3.12 | | 2.00 |
| | 4.49 | | 3.04 | | 2.00 |
| | 4.48 | | 3.02 | | 2.20 |
| | 4.46 | | 3.02 | | 2.20 |
| | 4.45 | | 2.92 | | 1.97 |
| | 4.44 | | 2.89 | | 1.96 |
| | 4.44 | | 2.89 | | 1.96 |
| | 4.40 | | 2.85 | | 1.95 |
| | 4.38 | | 2.84 | | 1.93 |
| | 4.35 | | 2.81 | | 1.91 |
| | 4.17 | | 2.80 | | 1.90 |
| | 4.13 | | 2.74 | | 1.90 |
| | 4.11 | | 2.73 | | 1.90 |
| | 4.10 | | 2.72 | | 1.86 |
| | 4.02 | | 2.70 | | 1.86 |
| | 4.02 | | 2.70 | | 1.85 |
| | 4.00 | | 2.70 | | 1.84 |
| | 4.00 | | 2.68 | | 1.83 |
| | 4.00 | | 2.64 | | 1.82 |
| | 3.95 | | 2.64 | | 1.80 |
| | 3.94 | | 2.60 | | 1.78 |
| | 3.78 | | 2.58 | | 1.72 |
| | 3.75 | | 2.57 | | 1.72 |
| | 3.74 | | 2.55 | | 1.71 |
| | 3.73 | | 2.50 | | 1.70 |
| | 3.72 | | 2.50 | | 1.69 |
| | 3.71 | | 2.46 | | 1.68 |
| | 3.71 | | 2.46 | | 1.68 |
| | 3.70 | | 2.45 | | 1.66 |
| | 3.68 | | 2.45 | | 1.60 |
| | 3.68 | | 2.44 | | 1.55 |
| | 3.61 | | 2.44 | | 1.54 |
| | 3.61 | | 2.43 | | 1.53 |
| | 3.60 | | 2.42 | | 1.50 |
| | 3.60 | | 2.38 | | 1.50 |
| | 3.54 | | 2.34 | | 1.50 |
| | 3.51 | | 2.32 | | 1.50 |
| | 3.51 | | 2.29 | | 1.50 |
| | 3.49 | | 2.25 | | 1.49 |
| | 3.46 | | 2.25 | | 1.49 |
| | 3.40 | | 2.22 | | 1.46 |
| | 3.37 | | 2.21 | | 1.45 |
| | | | 2.18 | | 1.45 |

| Zone | Weight | Zone | Weight | Zone | Weight |
|---|---|---|---|---|---|
| 11 | 1.45 | 11 | 0.90 | 11 | 0.55 |
| | 1.45 | | 0.88 | | 0.52 |
| | 1.43 | | 0.86 | | 0.52 |
| | 1.42 | | 0.85 | | 0.52 |
| | 1.40 | | 0.85 | | 0.51 |
| | 1.40 | | 0.83 | | 0.50 |
| | 1.39 | | 0.82 | | 0.50 |
| | 1.39 | | 0.82 | | 0.50 |
| | 1.34 | | 0.80 | | 0.49 |
| | 1.34 | | 0.80 | | 0.49 |
| | 1.32 | | 0.79 | | 0.49 |
| | 1.31 | | 0.78 | | 0.48 |
| | 1.30 | | 0.78 | | 0.48 |
| | 1.29 | | 0.77 | | 0.47 |
| | 1.27 | | 0.77 | | 0.47 |
| | 1.26 | | 0.75 | | 0.47 |
| | 1.25 | | 0.74 | | 0.46 |
| | 1.24 | | 0.73 | | 0.46 |
| | 1.19 | | 0.73 | | 0.46 |
| | 1.18 | | 0.72 | | 0.46 |
| | 1.17 | | 0.72 | | 0.45 |
| | 1.15 | | 0.70 | | 0.45 |
| | 1.15 | | 0.70 | | 0.45 |
| | 1.13 | | 0.70 | | 0.45 |
| | 1.12 | | 0.70 | | 0.44 |
| | 1.11 | | 0.70 | | 0.44 |
| | 1.10 | | 0.69 | | 0.43 |
| | 1.10 | | 0.69 | | 0.43 |
| | 1.10 | | 0.68 | | 0.42 |
| | 1.09 | | 0.66 | | 0.42 |
| | 1.09 | | 0.65 | | 0.42 |
| | 1.09 | | 0.65 | | 0.40 |
| | 1.05 | | 0.65 | | 0.40 |
| | 1.05 | | 0.65 | | 0.40 |
| | 1.03 | | 0.64 | | 0.39 |
| | 1.02 | | 0.64 | | 0.39 |
| | 1.02 | | 0.63 | | 0.38 |
| | 1.00 | | 0.61 | | 0.37 |
| | 0.98 | | 0.60 | | 0.35 |
| | 0.98 | | 0.60 | | 0.35 |
| | 0.98 | | 0.60 | | 0.34 |
| | 0.95 | | 0.59 | | 0.34 |
| | 0.95 | | 0.59 | | 0.34 |
| | 0.95 | | 0.58 | | 0.34 |
| | 0.94 | | 0.58 | | 0.34 |
| | 0.93 | | 0.58 | | 0.34 |
| | 0.92 | | 0.56 | | 0.33 |
| | 0.92 | | 0.55 | | 0.33 |
| | 0.90 | | 0.55 | | 0.32 |
| | 0.90 | | 0.55 | | 0.32 |

| Zone | Weight | Zone | Weight | Zone | Weight |
|---|---|---|---|---|---|
| 11 | 0.32 | 11 | 0.15 | 11 | 0.07 |
| | 0.31 | | 0.15 | | 0.07 |
| | 0.30 | | 0.15 | | 0.07 |
| | 0.30 | | 0.15 | | 0.07 |
| | 0.30 | | 0.15 | | 0.07 |
| | 0.30 | | 0.15 | | 0.06 |
| | 0.29 | | 0.15 | | 0.06 |
| | 0.29 | | 0.15 | | 0.06 |
| | 0.29 | | 0.15 | | 0.06 |
| | 0.28 | | 0.15 | | 0.06 |
| | 0.27 | | 0.15 | | 0.05 |
| | 0.26 | | 0.15 | | 0.05 |
| | 0.26 | | 0.15 | | 0.05 |
| | 0.25 | | 0.15 | | 0.05 |
| | 0.25 | | 0.14 | | 0.05 |
| | 0.25 | | 0.14 | | 0.05 |
| | 0.25 | | 0.14 | | 0.05 |
| | 0.25 | | 0.14 | | 0.05 |
| | 0.25 | | 0.14 | | 0.05 |
| | 0.25 | | 0.14 | | 0.05 |
| | 0.24 | | 0.13 | | 0.05 |
| | 0.24 | | 0.13 | | 0.05 |
| | 0.24 | | 0.12 | | 0.05 |
| | 0.24 | | 0.12 | | 0.04 |
| | 0.24 | | 0.12 | | 0.04 |
| | 0.24 | | 0.12 | | 0.04 |
| | 0.23 | | 0.12 | | 0.04 |
| | 0.23 | | 0.12 | | 0.04 |
| | 0.23 | | 0.12 | | 0.04 |
| | 0.22 | | 0.11 | | 0.04 |
| | 0.21 | | 0.11 | | 0.04 |
| | 0.21 | | 0.10 | | 0.04 |
| | 0.21 | | 0.10 | | 0.03 |
| | 0.21 | | 0.10 | | 0.03 |
| | 0.20 | | 0.10 | | 0.03 |
| | 0.20 | | 0.10 | | 0.03 |
| | 0.20 | | 0.10 | | 0.03 |
| | 0.20 | | 0.10 | | 0.03 |
| | 0.19 | | 0.10 | | 0.03 |
| | 0.19 | | 0.09 | | 0.03 |
| | 0.18 | | 0.09 | | 0.03 |
| | 0.18 | | 0.09 | | 0.03 |
| | 0.18 | | 0.09 | | 0.02 |
| | 0.18 | | 0.08 | | 0.02 |
| | 0.18 | | 0.08 | | 0.02 |
| | 0.17 | | 0.08 | | 0.02 |
| | 0.16 | | 0.08 | | 0.02 |
| | 0.16 | | 0.08 | | 0.02 |
| | 0.16 | | 0.08 | | 0.02 |
| | | | 0.07 | | 0.02 |

| Zone | Weight |
|---|---|
| 11 | 0.01 |
| | 0.01 |
| | 0.01 |
| | 0.01 |
| | 0.01 |
| | 0.01 |
| | 0.01 |
| | 0.01 |
| | 0.01 |
| | 0.01 |
| | 0.01 |
| | 0.01 |
| | 0.01 |
| | 0.01 |
| Total | 3912.61 |
| 12 | 12.74 |
| | 12.30 |
| | 10.76 |
| | 10.10 |
| | 7.42 |
| | 3.85 |
| | 3.60 |
| | 2.67 |
| | 2.66 |
| | 2.60 |
| | 2.39 |
| | 2.21 |
| | 1.75 |
| | 1.40 |
| | 1.25 |
| | 1.09 |
| | 0.95 |
| | 0.94 |
| | 0.90 |
| | 0.65 |
| | 0.62 |
| | 0.60 |
| | 0.55 |
| | 0.45 |
| | 0.42 |
| | 0.38 |
| | 0.30 |
| | 0.30 |
| | 0.23 |
| | 0.22 |
| | 0.20 |
| | 0.16 |

| Zone | Weight |
|---|---|
| 12 | 0.14 |
| | 0.08 |
| | 0.07 |
| Total | 86.95 |
| 13 | 27.39 |
| | 25.12 |
| | 21.60 |
| | 18.16 |
| | 17.93 |
| | 17.28 |
| | 16.05 |
| | 13.30 |
| | 12.17 |
| | 11.68 |
| | 9.83 |
| | 9.69 |
| | 9.60 |
| | 9.59 |
| | 9.37 |
| | 9.30 |
| | 7.69 |
| | 7.12 |
| | 6.34 |
| | 6.25 |
| | 6.14 |
| | 6.07 |
| | 5.94 |
| | 5.40 |
| | 5.37 |
| | 5.09 |
| | 4.92 |
| | 4.75 |
| | 4.55 |
| | 4.32 |
| | 3.95 |
| | 3.86 |
| | 3.85 |
| | 3.75 |
| | 3.69 |
| | 3.16 |
| | 3.10 |
| | 2.76 |
| | 2.73 |
| | 2.72 |
| | 2.52 |
| | 2.34 |
| | 2.20 |
| | 2.20 |

| Zone | Weight |
|---|---|
| 13 | 2.17 |
| | 2.08 |
| | 2.05 |
| | 2.04 |
| | 1.96 |
| | 1.87 |
| | 1.87 |
| | 1.76 |
| | 1.69 |
| | 1.66 |
| | 1.65 |
| | 1.45 |
| | 1.40 |
| | 1.36 |
| | 1.35 |
| | 1.35 |
| | 1.27 |
| | 1.08 |
| | 1.04 |
| | 1.00 |
| | 0.95 |
| | 0.89 |
| | 0.80 |
| | 0.72 |
| | 0.71 |
| | 0.67 |
| | 0.50 |
| | 0.47 |
| | 0.45 |
| | 0.42 |
| | 0.38 |
| | 0.30 |
| | 0.29 |
| | 0.26 |
| | 0.26 |
| | 0.24 |
| | 0.21 |
| | 0.19 |
| | 0.08 |
| | 0.07 |
| | 0.06 |
| | 0.04 |
| Total | 401.90 |
| 14 | 11.75 |
| | 9.50 |
| | 6.22 |
| | 4.85 |
| | 4.33 |

| Zone | Weight |
|---|---|
| 14 | 3.05 |
| | 3.00 |
| | 2.85 |
| | 2.62 |
| | 2.50 |
| | 2.26 |
| | 1.90 |
| | 1.80 |
| | 1.43 |
| | 1.26 |
| | 1.21 |
| | 1.20 |
| | 0.97 |
| | 0.89 |
| | 0.85 |
| | 0.80 |
| | 0.79 |
| | 0.77 |
| | 0.70 |
| | 0.65 |
| | 0.61 |
| | 0.59 |
| | 0.57 |
| | 0.52 |
| | 0.45 |
| | 0.43 |
| | 0.35 |
| | 0.34 |
| | 0.27 |
| | 0.20 |
| | 0.17 |
| | 0.10 |
| | 0.04 |
| Total | 72.79 |
| 15 | 7.36 |
| | 4.17 |
| | 3.20 |
| | 2.31 |
| | 2.02 |
| | 0.90 |
| | 0.64 |
| | 0.60 |
| | 0.53 |
| | 0.37 |
| | 0.03 |
| Total | 22.13 |

| Zone | Weight |
|---|---|
| 16 | 8.94 |
| | 3.12 |
| | 2.40 |
| | 1.39 |
| | 0.64 |
| | 0.42 |
| | 0.38 |
| | 0.27 |
| | 0.14 |
| | 0.07 |
| | 0.02 |
| Total | 17.79 |
| 17 | 24.72 |
| | 14.06 |
| | 12.78 |
| | 12.30 |
| | 7.85 |
| | 7.69 |
| | 7.56 |
| | 7.28 |
| | 7.11 |
| | 6.05 |
| | 5.57 |
| | 5.47 |
| | 5.37 |
| | 5.25 |
| | 5.14 |
| | 4.52 |
| | 4.42 |
| | 4.10 |
| | 3.75 |
| | 3.30 |
| | 3.20 |
| | 3.12 |
| | 3.09 |
| | 2.70 |
| | 2.70 |
| | 2.65 |
| | 2.60 |
| | 2.51 |
| | 2.23 |
| | 2.16 |
| | 1.89 |
| | 1.73 |
| | 1.70 |
| | 1.69 |
| | 1.59 |

| Zone | Weight |
|---|---|
| 17 | 1.40 |
| | 1.35 |
| | 1.33 |
| | 1.32 |
| | 1.26 |
| | 1.25 |
| | 1.23 |
| | 1.21 |
| | 1.20 |
| | 1.18 |
| | 1.14 |
| | 1.11 |
| | 1.10 |
| | 1.05 |
| | 1.05 |
| | 1.15 |
| | 0.92 |
| | 0.91 |
| | 0.87 |
| | 0.86 |
| | 0.80 |
| | 0.78 |
| | 0.76 |
| | 0.69 |
| | 0.66 |
| | 0.65 |
| | 0.65 |
| | 0.62 |
| | 0.61 |
| | 0.60 |
| | 0.60 |
| | 0.59 |
| | 0.56 |
| | 0.55 |
| | 0.53 |
| | 0.52 |
| | 0.45 |
| | 0.42 |
| | 0.40 |
| | 0.40 |
| | 0.40 |
| | 0.39 |
| | 0.39 |
| | 0.37 |
| | 0.37 |
| | 0.35 |
| | 0.35 |
| | 0.32 |
| | 0.32 |

| Zone | Weight |
|---|---|
| 17 | 0.30 |
| | 0.30 |
| | 0.25 |
| | 0.25 |
| | 0.25 |
| | 0.24 |
| | 0.23 |
| | 0.22 |
| | 0.21 |
| | 0.21 |
| | 0.20 |
| | 0.20 |
| | 0.20 |
| | 0.19 |
| | 0.18 |
| | 0.15 |
| | 0.15 |
| | 0.05 |
| | 0.05 |
| | 0.04 |
| | 0.95 |
| | 0.79 |
| Total | 233.45 |
| 18 | 49.40 |
| | 44.00 |
| | 38.28 |
| | 18.55 |
| | 17.28 |
| | 14.88 |
| | 14.09 |
| | 13.25 |
| | 12.55 |
| | 11.38 |
| | 10.83 |
| | 10.75 |
| | 10.67 |
| | 10.24 |
| | 9.90 |
| | 9.60 |
| | 9.58 |
| | 8.97 |
| | 8.74 |
| | 8.72 |
| | 8.70 |
| | 8.50 |
| | 7.80 |
| | 7.04 |
| | 6.63 |

| Zone | Weight | Code |
|---|---|---|
| 18 | 6.40 | |
| | 6.28 | B |
| | 6.26 | |
| | 6.10 | |
| | 5.59 | |
| | 5.15 | |
| | 5.14 | |
| | 5.13 | |
| | 4.75 | |
| | 4.44 | |
| | 4.27 | |
| | 4.27 | |
| | 3.95 | |
| | 3.86 | |
| | 3.25 | |
| | 3.21 | |
| | 3.13 | |
| | 3.10 | |
| | 2.97 | |
| | 2.95 | |
| | 2.66 | |
| | 2.62 | |
| | 2.59 | |
| | 2.57 | |
| | 2.55 | |
| | 2.50 | |
| | 2.45 | |
| | 2.40 | |
| | 2.40 | |
| | 2.34 | |
| | 2.32 | |
| | 2.25 | |
| | 2.25 | |
| | 2.24 | |
| | 2.12 | |
| | 2.05 | |
| | 2.05 | |
| | 1.91 | |
| | 1.82 | |
| | 1.80 | |
| | 1.78 | |
| | 1.75 | |
| | 1.71 | |
| | 1.70 | |
| | 1.69 | |
| | 1.64 | |
| | 1.60 | |
| | 1.55 | |
| | 1.47 | |
| | 1.47 | |
| | 1.45 | |

| Zone | Weight | Code |
|---|---|---|
| 18 | 1.41 | |
| | 1.40 | |
| | 1.39 | |
| | 1.34 | |
| | 1.27 | |
| | 1.25 | |
| | 1.25 | |
| | 1.24 | |
| | 1.20 | |
| | 1.20 | |
| | 1.20 | |
| | 1.20 | |
| | 1.19 | |
| | 1.15 | |
| | 1.15 | B |
| | 1.14 | |
| | 1.07 | |
| | 1.07 | |
| | 1.06 | |
| | 1.04 | |
| | 1.03 | |
| | 1.02 | |
| | 0.97 | |
| | 0.95 | |
| | 0.95 | |
| | 0.87 | |
| | 0.86 | |
| | 0.85 | |
| | 0.85 | |
| | 0.83 | |
| | 0.80 | |
| | 0.78 | |
| | 0.75 | |
| | 0.74 | |
| | 0.70 | |
| | 0.69 | |
| | 0.62 | |
| | 0.60 | |
| | 0.60 | |
| | 0.55 | |
| | 0.55 | |
| | 0.52 | |
| | 0.50 | |
| | 0.50 | |
| | 0.46 | |
| | 0.46 | |
| | 0.41 | |
| | 0.37 | |
| | 0.35 | |
| | 0.34 | |
| | 0.34 | |

| Zone | Weight | Code |
|---|---|---|
| 18 | 0.33 | |
| | 0.33 | |
| | 0.32 | |
| | 0.32 | |
| | 0.30 | |
| | 0.30 | |
| | 0.26 | |
| | 0.26 | |
| | 0.25 | B |
| | 0.22 | |
| | 0.22 | |
| | 0.21 | |
| | 0.21 | |
| | 0.20 | |
| | 0.19 | |
| | 0.19 | |
| | 0.19 | |
| | 0.18 | |
| | 0.18 | B |
| | 0.17 | |
| | 0.16 | |
| | 0.14 | |
| | 0.12 | |
| | 0.12 | |
| | 0.12 | |
| | 0.12 | |
| | 0.12 | B |
| | 0.11 | |
| | 0.10 | |
| | 0.05 | |
| | 0.05 | |
| Total | 575.30 | |
| 19 | 306.00 | B |
| | 41.40 | B |
| | 22.35 | B |
| | 17.48 | B |
| | 14.72 | B |
| | 12.05 | B |
| | 8.30 | B |
| | 8.14 | |
| | 7.62 | B |
| | 7.54 | B |
| | 7.20 | B |
| | 6.54 | B |
| | 5.86 | |
| | 5.74 | B |
| | 5.62 | |
| | 5.58 | |

| Zone | Weight | Code |
|---|---|---|
| 19 | 5.56 | B |
| | 5.45 | B |
| | 5.25 | B |
| | 5.00 | |
| | 4.91 | B |
| | 4.75 | |
| | 4.29 | B |
| | 4.20 | B |
| | 4.15 | B |
| | 3.96 | B |
| | 3.94 | B |
| | 3.82 | B |
| | 3.66 | |
| | 3.62 | |
| | 3.45 | |
| | 3.30 | B |
| | 3.30 | B |
| | 3.28 | |
| | 3.25 | B |
| | 3.16 | B |
| | 3.05 | B |
| | 2.90 | B |
| | 2.70 | B |
| | 2.52 | B |
| | 2.46 | B |
| | 2.42 | B |
| | 2.40 | B |
| | 2.30 | B |
| | 2.28 | B |
| | 2.20 | B |
| | 2.16 | B |
| | 2.16 | B |
| | 2.15 | |
| | 2.13 | B |
| | 2.12 | B |
| | 1.98 | B |
| | 1.97 | B |
| | 1.95 | |
| | 1.89 | B |
| | 1.86 | B |
| | 1.85 | B |
| | 1.78 | B |
| | 1.75 | B |
| | 1.49 | B |
| | 1.40 | B |
| | 1.35 | B |
| | 1.34 | |
| | 1.29 | B |
| | 1.24 | B |
| | 1.20 | B |

| Zone | Weight | Code |
|---|---|---|
| 19 | 1.20 | B |
| | 1.18 | |
| | 1.14 | B |
| | 1.09 | |
| | 1.06 | |
| | 1.02 | B |
| | 1.00 | B |
| | 0.93 | B |
| | 0.88 | |
| | 0.87 | B |
| | 0.80 | B |
| | 0.80 | B |
| | 0.79 | |
| | 0.71 | |
| | 0.70 | B |
| | 0.65 | B |
| | 0.64 | B |
| | 0.62 | B |
| | 0.60 | B |
| | 0.53 | B |
| | 0.52 | B |
| | 0.48 | |
| | 0.47 | B |
| | 0.47 | B |
| | 0.42 | B |
| | 0.42 | |
| | 0.42 | |
| | 0.40 | B |
| | 0.40 | B |
| | 0.36 | B |
| | 0.36 | B |
| | 0.35 | |
| | 0.34 | B |
| | 0.34 | B |
| | 0.34 | B |
| | 0.34 | B |
| | 0.32 | B |
| | 0.30 | B |
| | 0.30 | |
| | 0.29 | B |
| | 0.28 | B |
| | 0.28 | B |
| | 0.25 | |
| | 0.25 | B |
| | 0.24 | B |
| | 0.24 | B |
| | 0.24 | |
| | 0.23 | B |
| | 0.22 | B |
| | 0.21 | B |

| Zone | Weight | Code |
|---|---|---|
| 19 | 0.20 | B |
| | 0.20 | B |
| | 0.20 | |
| | 0.18 | B |
| | 0.17 | B |
| | 0.17 | B |
| | 0.15 | |
| | 0.15 | B |
| | 0.15 | B |
| | 0.15 | B |
| | 0.15 | B |
| | 0.13 | B |
| | 0.13 | B |
| | 0.13 | B |
| | 0.13 | B |
| | 0.12 | B |
| | 0.12 | B |
| | 0.12 | |
| | 0.10 | B |
| | 0.10 | B |
| | 0.09 | B |
| | 0.07 | B |
| | 0.07 | |
| | 0.06 | B |
| | 0.04 | B |
| | 0.04 | B |
| | 0.04 | |
| | 0.03 | B |
| | 0.03 | B |
| | 0.02 | B |
| | 0.02 | B |
| | 0.02 | B |
| | 0.02 | B |
| Total | 655.52 | |
| 19B | 18.72 | B |
| | 9.62 | |
| | 8.75 | |
| | 8.64 | |
| | 7.78 | |
| | 6.57 | |
| | 5.33 | |
| | 4.82 | |
| | 3.92 | B |
| | 3.80 | |
| | 3.12 | |
| | 2.90 | |
| | 2.79 | |
| | 1.80 | |

| Zone | Weight | Code |
|---|---|---|
| 19B | 1.29 | |
| | 1.22 | |
| | 1.10 | |
| | 1.00 | |
| | 0.94 | |
| | 0.90 | |
| | 0.90 | |
| | 0.84 | |
| | 0.80 | |
| | 0.77 | |
| | 0.60 | |
| | 0.50 | B |
| | 0.44 | |
| | 0.42 | |
| | 0.33 | |
| | 0.32 | B |
| | 0.30 | B |
| | 0.26 | B |
| | 0.25 | B |
| | 0.23 | |
| | 0.22 | B |
| | 0.20 | B |
| | 0.18 | |
| | 0.17 | B |
| | 0.15 | B |
| | 0.14 | B |
| | 0.10 | |
| | 0.07 | |
| | 0.05 | B |
| Total | 103.25 | |
| 18B | 5.87 | |
| | 5.09 | |
| | 3.83 | |
| | 3.67 | |
| | 2.70 | |
| | 2.34 | |
| | 1.99 | |
| | 1.63 | |
| | 1.39 | B |
| | 1.38 | |
| | 1.25 | |
| | 1.04 | |
| | 1.00 | |
| | 0.95 | |
| | 0.80 | |
| | 0.79 | |
| | 0.74 | |
| | 0.56 | |

| Zone | Weight | Code |
|---|---|---|
| 18B | 0.41 | |
| | 0.39 | |
| | 0.39 | B |
| | 0.32 | |
| | 0.22 | |
| | 0.18 | |
| | 0.18 | B |
| | 0.12 | |
| | 0.87 | |
| Total | 40.10 | |

GRAND TOTAL

No. 1841

Weight Grains 14,691.28

Code: F - Fuze
B - Brass
NR - No Recovery

APPENDIX C

Analytical Laboratory Report 60-AL-18
5 February 1960

Title: Results of Fragmentation Test of 115-mm Shell, HE, XM378

Project No.: TW-201/01

Prepared for: Bomb & Fragmentation Br, Inf & Acft Wpns Div

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## (U) INTRODUCTION

A static fragmentation test was conducted to obtain the velocity, mass, and distribution of fragments for the 115-mm HE Shell, XM378, Comp B loaded. Three shells were detonated for this purpose. This report discusses the procedures and results of the test and presents the data in the form required by the EDVAC for lethality studies.

## (U) DESCRIPTION OF TEST ARENA

A square fragmentation arena was used for this test. In this arrangement, the recovery area consists of sheets of cellotex stacked to a suitable depth and placed in a rectangular pattern from 0° to 180° as measured from the nose to the base of the shell. The other side of the arena, also rectangular, was used for velocity measurement. The velocity panels consist of 4 ft by 8 ft sheets of 0.020-inch dural with photoflash bulbs mounted behind them for back-lighting, and aluminum foil to serve as a reflecting surface.

Since the shell is symmetrical about its axis, the fragmentation characteristics are assumed to be symmetric; i.e., the fragment velocity, density, and spatial distribution obtained from one region are assumed to be equivalent to those of the symmetrically located region. Because of the possibility of irregular shell break-up in the nose and base areas, recovery boxes were placed outside the velocity targets at the nose and base ends. The recovery area was divided into angular intervals or zones, numbered 1 through 19, from the nose to the base of the shell. Zones 1 and 19 covered the angular interval 0° to 5° and 175° to 180°, respectively, as measured from the axis at the nose. Zones 2 through 18 covered the angle from 5° to 175° for each interval of 10°. The extra recovery boxes were placed at the nose, to recover fragments in areas symmetric to Zones 1 and 2, and at the base to recover fragments in areas symmetric to Zones 18 and 19.

The velocity panels were painted with a rectangular grid system to aid in locating hits on the film for velocity measurements.

A sketch of the test arena is shown in Figure 1, Inclosure 1.

## (U) PROCEDURE FOR COLLECTING DATA

### Weight of Fragments

After each round was detonated, the fragments were recovered from the cellotex, located with regard to zone, and weighed to an accuracy of 1% or a minimum of 0.01 grains.

### Velocity of Fragments

High speed cameras (approximately 10,000 frames per second) were positioned so as to view the dural targets. The flashes of the fragment impacts on the dural were then recorded on the film record along with a millisecond time base. The flashbulb backlighting provided an additional source of light and made possible the recording of impacts that were produced by fragments with velocities too low (less than approximately 1700 fps) to produce a flash. The backlighting also provided more even illumination of each perforation than that normally obtained from impact alone. The photographic velocities, $V_p$, were determined from the time of flight for each fragment and the known travel distance. These distances from surface of shell to the target were calculated in such a manner that the error in the travel distance was less than $\pm 1\%$. The velocities were then grouped into the same angular intervals as the fragment mass data.

A detailed description of the methods used in collecting and reducing fragmentation data is contained in Report No. D&PS/APG Misc/306 dated September 1959.

## (U) REDUCTION OF DATA

### Initial Velocity of Fragments

The initial velocities, $V_o$, of the fragments for each angular interval were obtained from the equation

$$V_o = V_p \frac{e^{\frac{ar}{m_r^{1/3}}} - 1}{\frac{ar}{m_r^{1/3}}}$$

where $a = 12 K_d \rho K^{-2/3}$ ; $K = \frac{m}{A^{3/2}}$

The parameters needed to evaluate $V_o$ by this relation were obtained as follows:

$V_p$ - Photographic velocity (fps) is the median of the velocities for each zone. These velocities were determined by the relation r/t where r was the travel distance and t was the time of flight.

$K_d$ - The value of $K_d$ (Drag Coefficient) = .64 was obtained by determining an average value for $K_d$ over the range of fragment velocities. $K_d$ as a function of Mach number for a particular shaped fragment was obtained from BRL Report No. M-915.

$\rho$ - For air density a standard value of .304332 grains/in.$^3$ (standard at APG) was adjusted to conditions at the time of firing by using the relative air density obtained from the Meteorological Section, Development and Proof Services.

K - The fragment shape factor K = 593 was calculated from a relationship between K and C/m developed by Terminal Ballistics Laboratory, BRL. In the relation C/m is the ratio of the charge to metal weight.

$m_r$ - The representative fragment weight, used in the equation was that fragment weight for which the total weight of all the smaller fragments is one-half the total weight recovered in a particular zone.

Number and Density of Fragments

The scaled total number of fragments for each round was calculated from the scaled fragment densities obtained from the recovery data. The total number of fragments N was calculated by the equation

$$N = 2\pi \int_0^{\pi} \sigma'(\theta) \sin \theta \, d\theta$$

where $\theta$ is the angle from the nose end of the shell axis and $\sigma'(\theta)$ is the scaled number of fragments per unit solid angle for each 10° interval. The term "scaled" refers to an adjustment of data based on the percent of recovery.

## (U) RESULTS

The calculated results are tabulated for each round and for the three-round average in Inclosure 2. The data are arranged in the form required by the EDVAC code for the computation of lethal areas. The fragment spray density, and the median initial velocity, $V_o$, are given for each 10° interval from 0° to 180°. The mean, $\bar{m}$, of the fragment weights, in each weight interval and the ratio, q, of the number of fragments in each weight interval to the total number of

fragments in the angular interval are given for each weight and angular interval.

It should be pointed out that the values of velocity, density, etc tabulated for each angular interval were computed from data obtained for a given angular width. Therefore, these are considered to be average values applicable at the midpoint of each angular interval i.e., values given for $\theta = 60^{\circ}$ were derived from data obtained from $\theta = 55^{\circ}$ to $\theta = 65^{\circ}$.

Graphs

Graphs of the pertinent data: distribution of fragment weight and number, density, and velocity are presented in Figures 2-7, Inclosure 1.

(C) DISCUSSION OF RESULTS

The weights of the components of the three shell tested are given in the following table:

Weight in Pounds

| Rd. No. | Empty Shell | Loaded Shell | Comp B | Fuze | As Fired |
|---|---|---|---|---|---|
| 1 | 22.16 | 32.55 | 10.39 | 1.51 | 34.06 |
| 2 | 22.04 | 32.45 | 10.41 | 1.51 | 33.96 |
| 3 | 21.63 | 32.15 | 10.52 | 1.51 | 33.66 |

Each test item was a two-piece shell of pearlitic malleable iron. The body and base sections were joined just forward of the rotating band. No weight data were available on these separate parts of the shell.

The actual and integrated recovery data are given for the three rounds in the following table:

Actual Recovery

| Rd. No. | Total Wt. gr. | Total No. of frags | Average Frag Wt. Gr. | As Fired Metal Parts Wt. lb. |
|---|---|---|---|---|
| 1 | 14374.12 | 1886 | 7.62 | 23.67 |
| 2 | 14593.25 | 1833 | 7.96 | 23.55 |
| 3 | 14691.29 | 1841 | 7.98 | 23.14 |

Integrated Recovery

| Rd. No. | Wt. Lb. | No. of Frags | Ave Frag Wt. Gr. | Percent Recovery | Scaled No. of Frags |
|---|---|---|---|---|---|
| 1 | 22.263 | 31836 | 4.90 | 94.1 | 33841 |
| 2 | 21.165 | 24903 | 5.95 | 89.9 | 27717 |
| 3 | 20.177 | 30328 | 4.66 | 87.2 | 34787 |
| Ave | | | 5.11 | 90.4 | 32115 |

The data above shows approximately 20% fewer fragments for Rd. No. 2 than the average of the other two rounds. A further separation was made to more clearly define the differences in the scaled number of fragments for the three rounds.

Number and Percent of Fragments per Angular Interval

| Rd. No. | 0° - 75° | | 75°-115° | | 115°-180° | |
|---|---|---|---|---|---|---|
| | No. | % of Total | No. | % of Total | No. | % of Total |
| 1 | 1315 | 3.9 | 27691 | 81.8 | 4836 | 14.3 |
| 2 | 2008 | 7.2 | 20392 | 73.6 | 5317 | 19.2 |
| 3 | 1296 | 3.7 | 28224 | 81.1 | 5266 | 15.1 |

As shown in the above tabulation, approximately 75% of the fragments were in an angular interval extending from approximately 75°-115°.

Also, a difference of approximately 8000 fragments is shown between Rd. 2 and the average of Rds. 1 and 3 for this angular interval. Inasmuch as about 40% of the fragments were in the smallest weight interval, 0-1 grains, a tabulation of the number of fragments for the above angular intervals was made excluding the fragments in the 0-1 grain weight interval. These values are given below.

Number of Fragments per Angular Interval
(Excluding frags. weighing less than 1 gr)

| Rd. No. | 0°-75° No. | 75°-115° No. | 115°-180° No. | 0°-180° No. |
|---|---|---|---|---|
| 1 | 700 | 14873 | 2631 | 18204 |
| 2 | 801 | 13224 | 2676 | 16701 |
| 3 | 564 | 15539 | 3117 | 19220 |

From these data it is apparent that while there is shown to be a difference in the number of fragments for the shell tested, most of this difference occurred in the number of fragments weighing less than one grain, indicating that Rd. 2 produced slightly heavier fragments.

The initial velocities of the three rounds were in good agreement and had a maximum average of value of 7300 fps at an angle of approximately 90°, see Figure 2, Inclosure 1. The velocities for the individual rounds actually exhibited two maximum values in this area, one occurring at 90° and the other at 110°. Furthermore the maximum fragment density occurred at an angle of approximately 100° for all rounds. The variation between rounds in maximum fragment density in the main spray area (Figure 3, Inclosure 1) reflects the effect of the small fragments, 0-1 grains.

The plot of N(m) vs $m^{1/2}$ see Figure 7, Inclosure 1, shows a good fit to Mott's Law for fragments weighing less than approximately 250 grains, which would include almost all of the fragments.

SUBMITTED:

Henry L. Barnhart

Henry L. Barnhart
Mathematician

REVIEWED:

W. E. Canby for

J. E. Steedman
Chief, Ballistics Section

APPROVED:

A. E. Karp

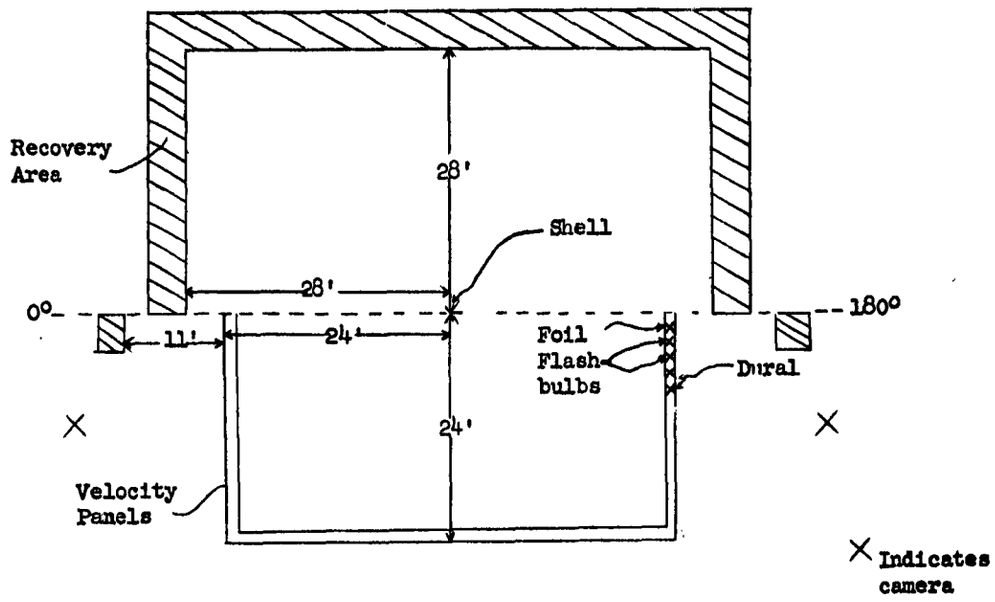
A. E. KARP
Chief, Analytical Laboratory

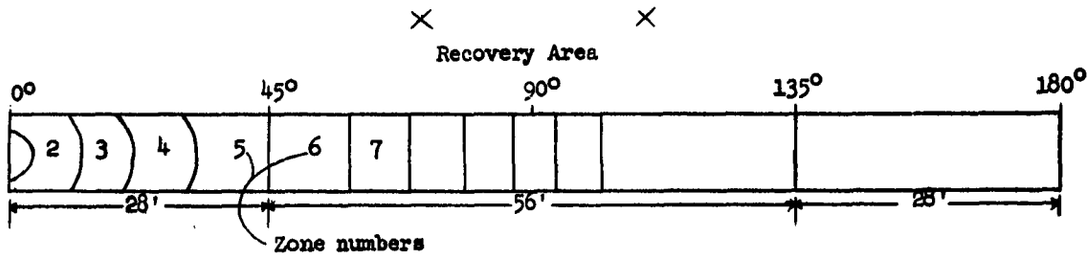
Engineering Laboratories
Supporting Services
Development and Proof Services
Aberdeen Proving Ground, Maryland

Inclosure 1
- Figure 1 Sketch of Fragmentation Arena
- Figure 2 Plot of Initial Velocity, $V_o$, vs angle $\theta$
- Figure 3 Plot of Fragment Density, $\sigma$, vs Angle $\theta$
- Figure 4 Graph of percent Wt. and No. vs Wt. Interval
- Figure 5 Plot of Scaled no. of Frags vs Angle $\theta$
- Figure 6 Plot of Accumulated No. Vs Angle $\theta$
- Figure 7 Plot of N(m) vs $m^{1/2}$

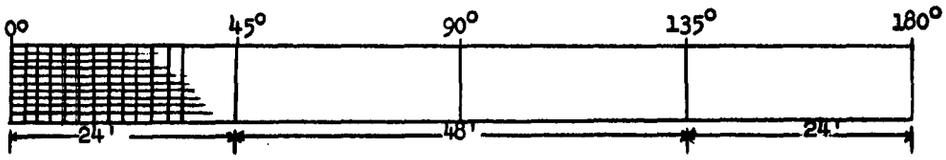
Inclosure 2
- Tabulated Data

Fragmentation Arena




Velocity Area




Inclosure 1, Figure 1



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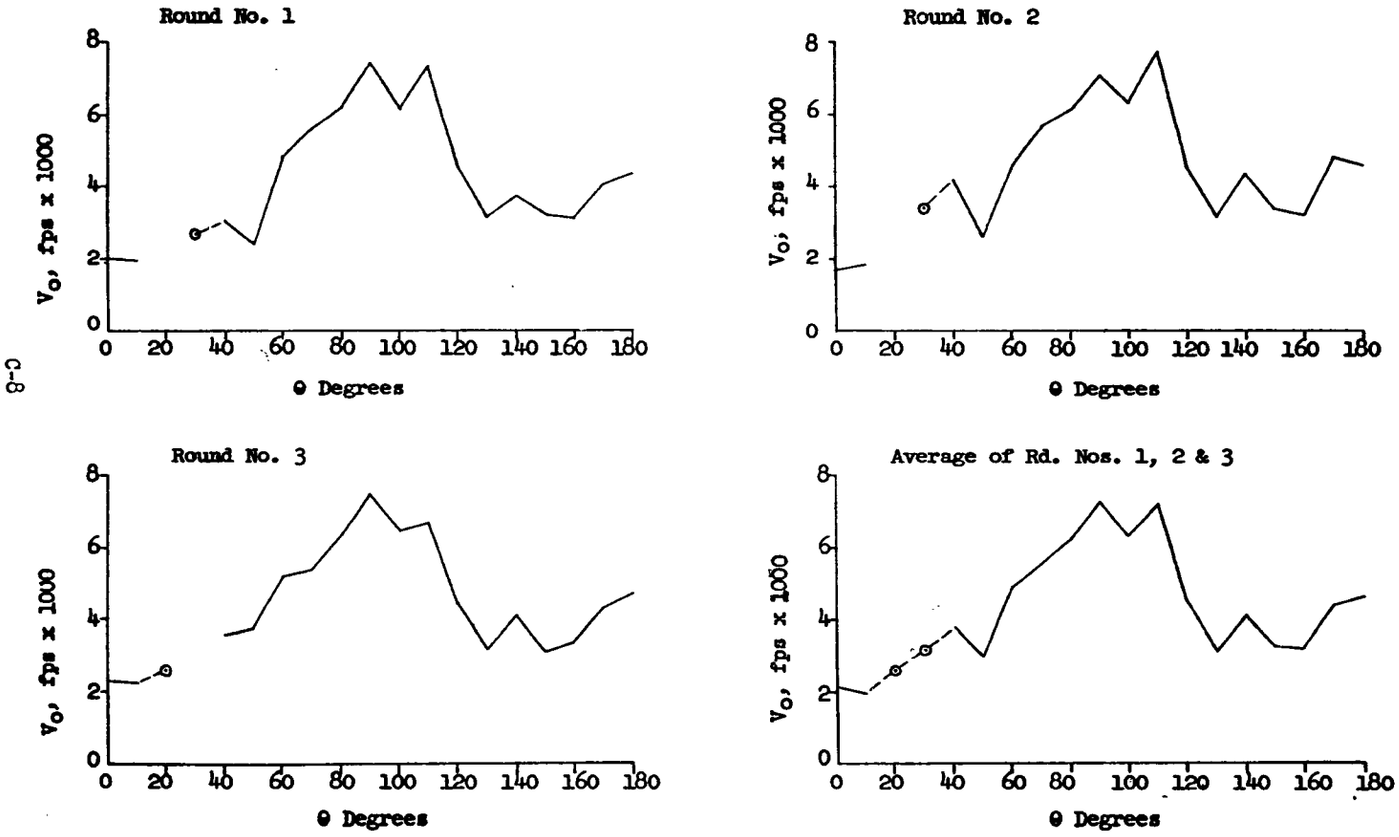
Initial Velocity, $V_o$, vs Angle $\theta$
115-mm Shell, HE, XM378




$\theta$ measured from fuze end of shell

Inclosure 1, Figure 2

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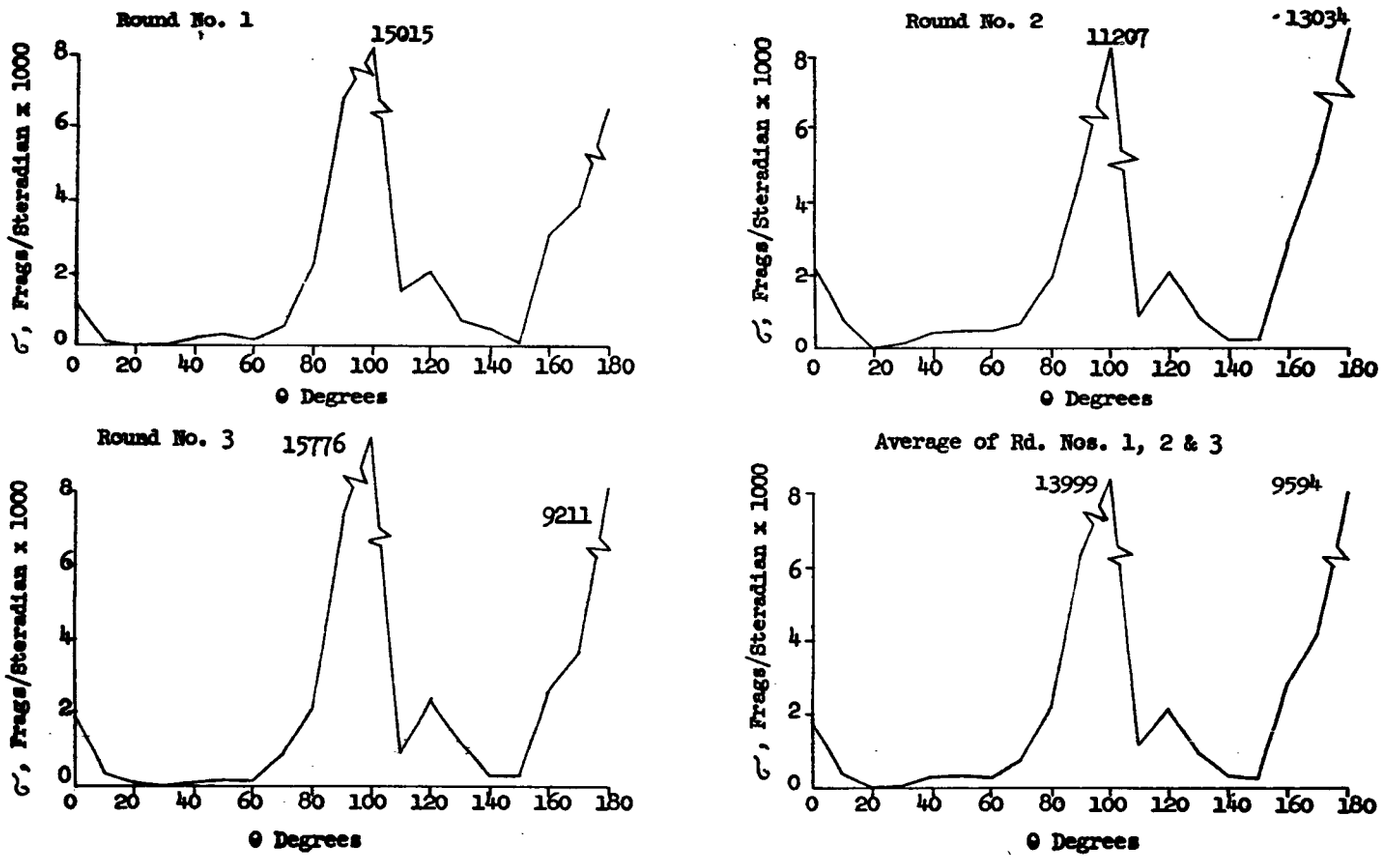
Fragment Density, $\sigma$, vs Angle $\theta$
115-mm Shell, HE, XM378




θ measured from fuze end of shell

Inclosure 1, Figure 3

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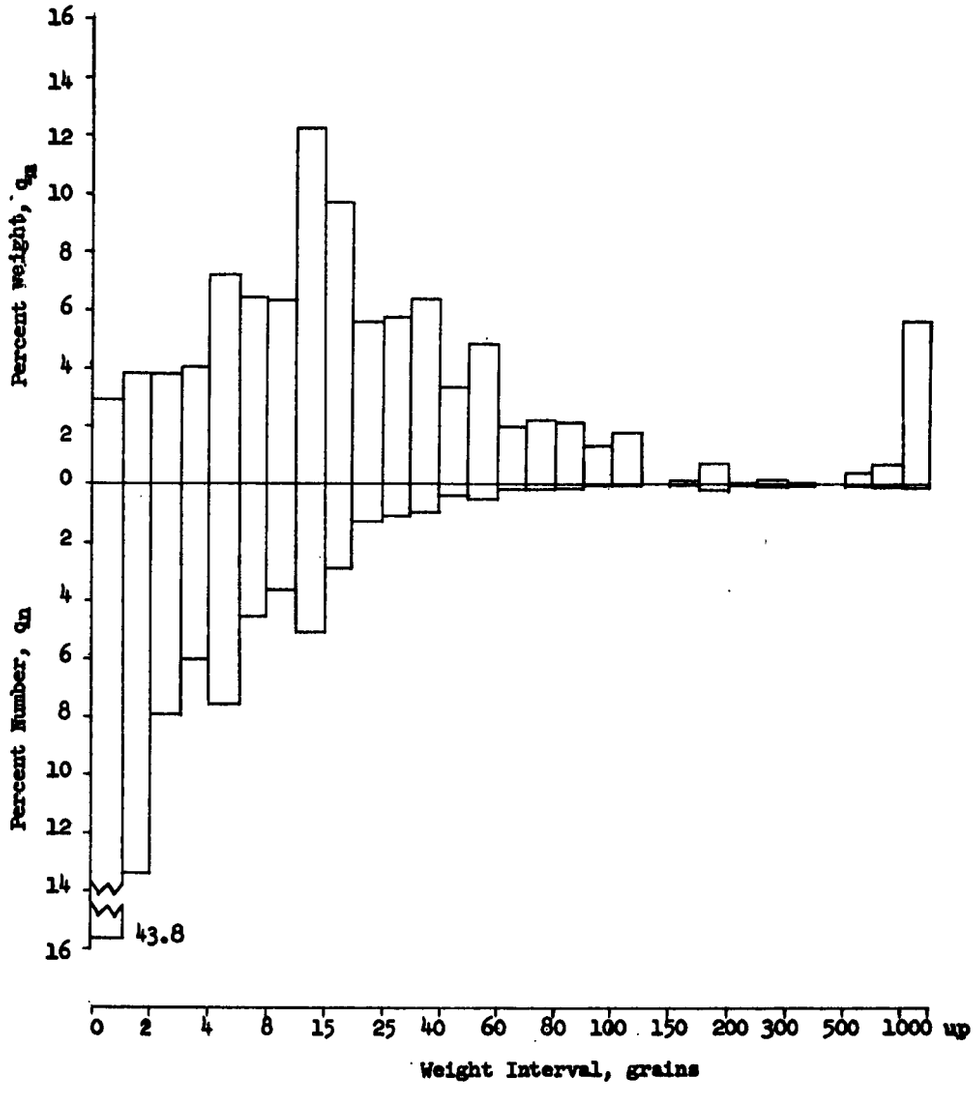
Percent Weight and Number ($q_m$, $q_n$) vs
Weight Interval
115-mm Shell, HE, XM378
Average of Rds.: 1, 2, and 3




Inclosure 1, Figure 4

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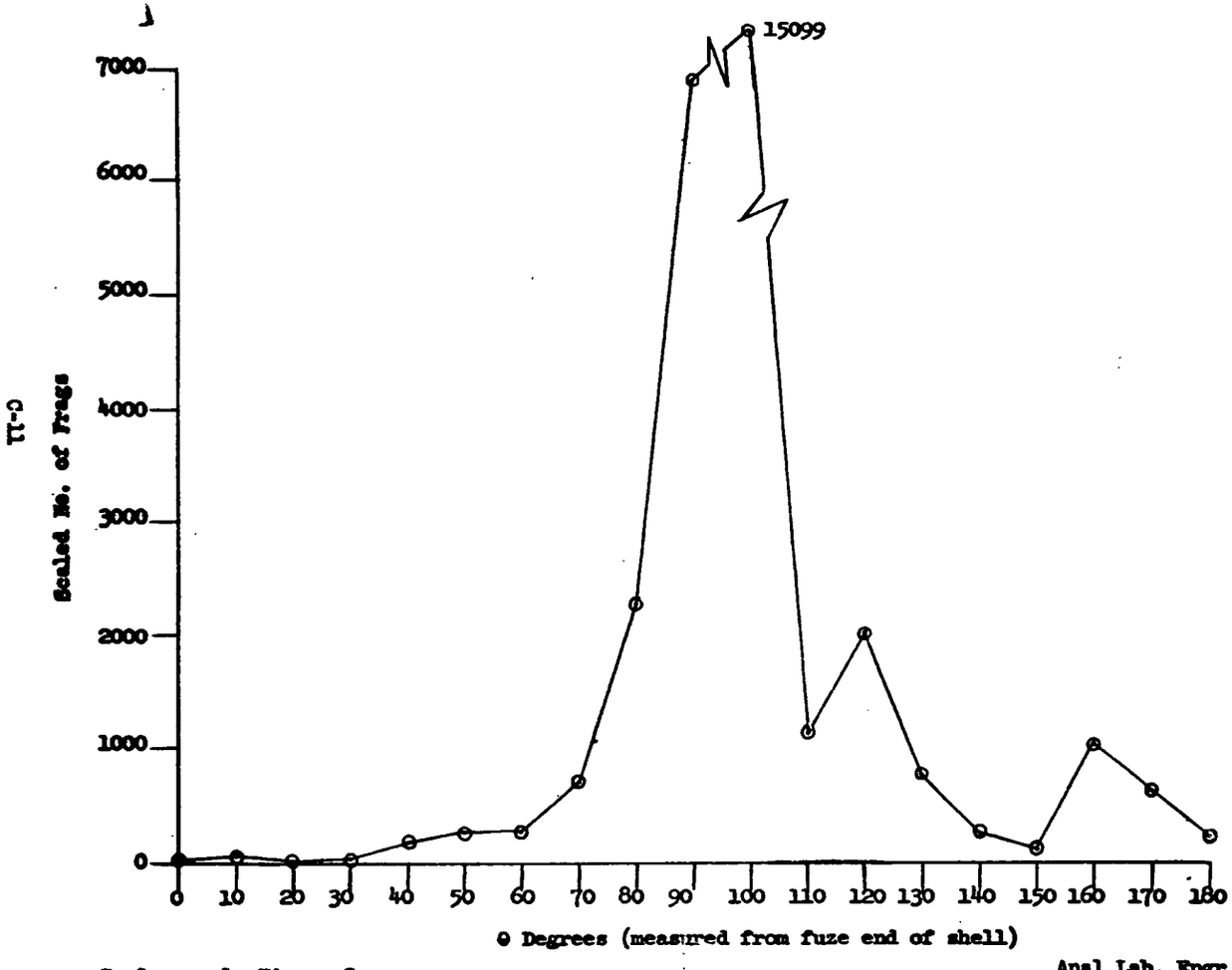
Scaled Number of Fragments vs Angle θ
115-mm Shell, HE, XM378
Average of Rds. 1, 2 and 3

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Inclosure 1, Figure 5

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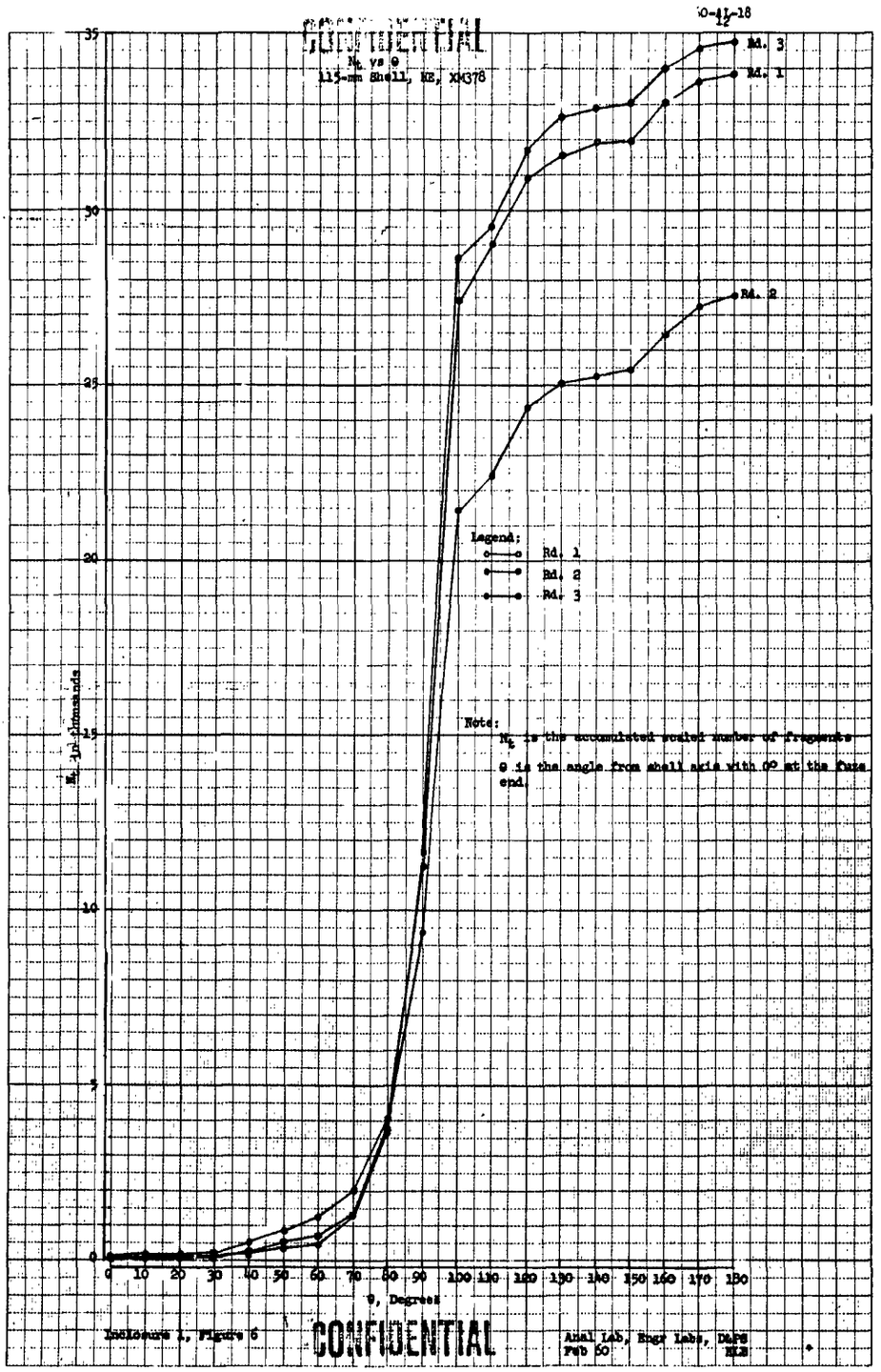
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$N_\theta$ vs $\theta$
115-mm Shell, HE, XM378
0-41/2-18
Rd. 3
Rd. 1
Rd. 2
Legend:
Rd. 1
Rd. 2
Rd. 3
Note:
$N_\theta$ is the accumulated scaled number of fragments
$\theta$ is the angle from shell axis with 0° at the fuze end.
$N_\theta$, In Thousands
0
5
10
15
20
25
30
35
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180
θ, Degrees
Enclosure 1, Figure 6
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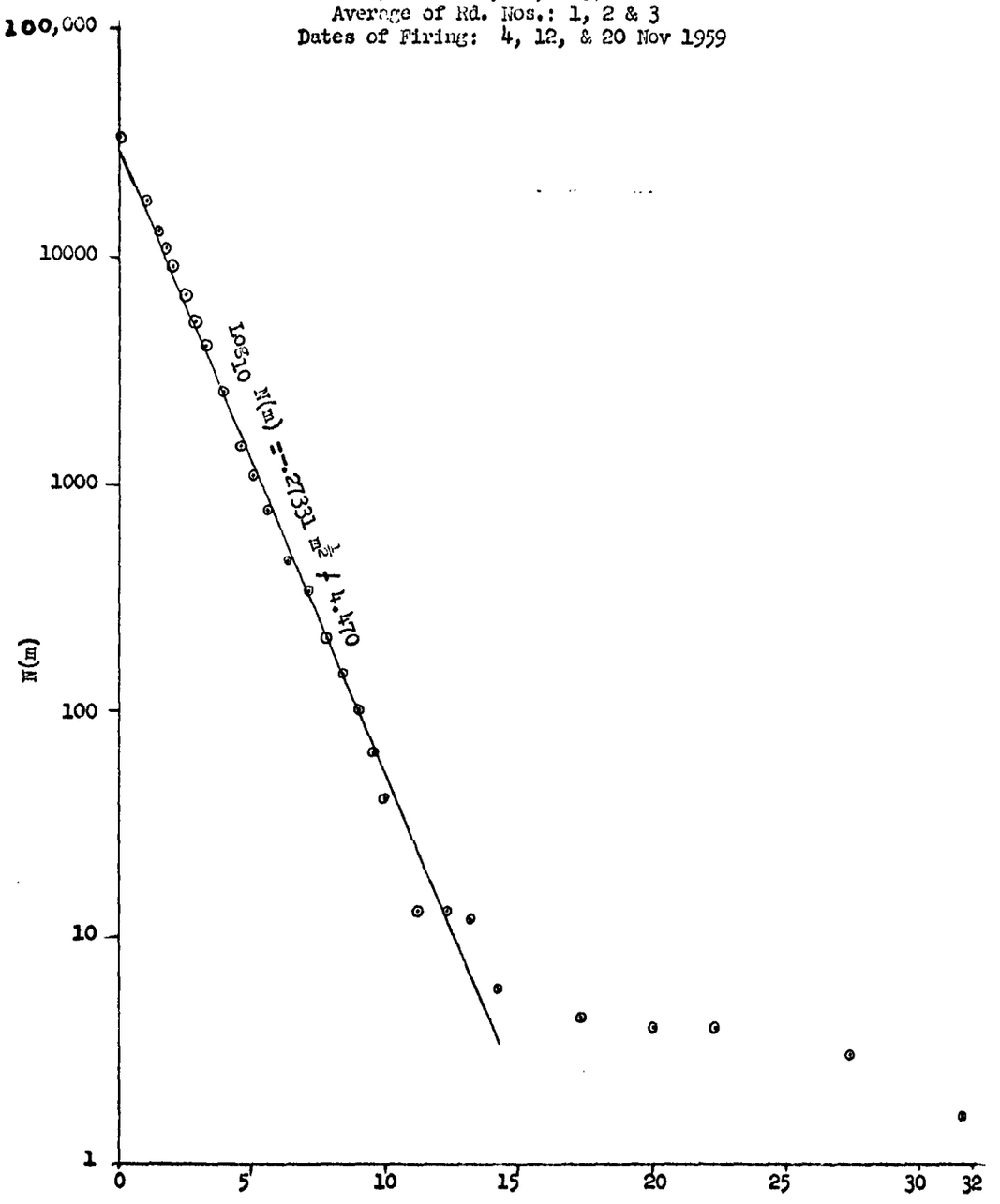
N(m) vs $m^{\frac{1}{2}}$
115-mm Shell, HE, XM378
Average of Rd. Nos.: 1, 2 & 3
Dates of Firing: 4, 12, & 20 Nov 1959




N(m) = number of fragments of weight greater than m

Inclosure 1, Figure 7



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Fragment Velocity and Density

Ave of Rds., 1, 2, & 3 Dates of Firing: 4, 12 & 20 Nov 1959

| $\theta$ Degrees | $V_o$ Initial Velocity, fps | Density Frag/Steradian |
|---|---|---|
| 0 | 2100 | 1707 |
| 10 | 1950 | 392 |
| 20 | [a]2550 | 24 |
| 30 | [a]3200 | 42 |
| 40 | 3800 | 265 |
| 50 | 3000 | 300 |
| 60 | 4900 | 267 |
| 70 | 5550 | 694 |
| 80 | 6200 | 2124 |
| 90 | 7300 | 6300 |
| 100 | 6300 | 13999 |
| 110 | 7200 | 1112 |
| 120 | 4500 | 2140 |
| 130 | 3150 | 900 |
| 140 | 4100 | 369 |
| 150 | 3300 | 239 |
| 160 | 3250 | 2780 |
| 170 | 4350 | 4513 |
| 180 | 4600 | 9594 |

In the equation $V_r = V_o e^{-\frac{ar}{m^{1/3}}}$,

where $V_r$ and $V_o$ are velocities in feet per second, m is weight in grains, and r is distance in feet,

a = .033 for standard conditions

Percent Recovery = 90.4

[a]Interpolated values

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Fragment Velocity and Density

Round Number 1 Date of Firing: 4 Nov 1959

| θ Degrees | $V_o$ Initial Velocity fps | σ Density Frag/Steradian |
|---|---|---|
| 0 | 2000 | 1156 |
| 10 | 1950 | 129 |
| 20 | | 0 |
| 30 | [a]2700 | 24 |
| 40 | 3050 | 275 |
| 50 | 2400 | 308 |
| 60 | 4800 | 199 |
| 70 | 5550 | 596 |
| 80 | 6200 | 2298 |
| 90 | 7400 | 6790 |
| 100 | 6150 | 15015 |
| 110 | 7300 | 1535 |
| 120 | 4600 | 2036 |
| 130 | 3150 | 729 |
| 140 | 3750 | 522 |
| 150 | 3250 | 97 |
| 160 | 3150 | 3000 |
| 170 | 4050 | 3856 |
| 180 | 4350 | 6536 |

In the equation

$$V_r = V_o e^{-\frac{ar}{m^{1/3}}},$$

where $V_r$ and $V_o$ are velocities in feet per second, m is weight in grains, and r is distance in feet,

a = .033 for standard conditions

Percent Recovery = 94.1

[a]Interpolated values

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## Fragment Velocity and Density

Round Number 2 Date of Firing: 12 Nov 1959

| θ Degrees | $V_o$ Initial Velocity, fps | Density Frag/Steradian |
|---|---|---|
| 0 | 1700 | 2141 |
| 10 | 1850 | 731 |
| 20 | | 0 |
| 30 | [a]3400 | 102 |
| 40 | 4150 | 403 |
| 50 | 2650 | 411 |
| 60 | 4550 | 468 |
| 70 | 5650 | 696 |
| 80 | 6100 | 1902 |
| 90 | 7050 | 4830 |
| 100 | 6300 | 11207 |
| 110 | 7700 | 936 |
| 120 | 4500 | 2080 |
| 130 | 3150 | 822 |
| 140 | 4350 | 259 |
| 150 | 3350 | 331 |
| 160 | 3200 | 2817 |
| 170 | 4800 | 6018 |
| 180 | 4550 | 13034 |

In the equation

$$V_r = V_o e^{-\frac{ar}{m^{1/3}}},$$

where $V_r$ and $V_o$ are velocities in feet per second, m is weight in grains, and r is distance in feet,

a = .033 for standard conditions

Percent Recovery = 89.9

[a]Interpolated values

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Fragment Velocity and Density

Round Number 3 Date of Firing: 20 Nov 1959

| θ Degrees | $V_o$ Initial Velocity, fps | σ Density Frag/Steradian |
|---|---|---|
| 0 | 2250 | 1823 |
| 10 | [a]2000 | 317 |
| 20 | [a]2550 | 71 |
| 30 | | 0 |
| 40 | 3600 | 119 |
| 50 | 3750 | 181 |
| 60 | 5200 | 134 |
| 70 | 5400 | 791 |
| 80 | 6350 | 2173 |
| 90 | 7500 | 7280 |
| 100 | 6500 | 15776 |
| 110 | 6700 | 865 |
| 120 | 4450 | 2305 |
| 130 | 3250 | 1149 |
| 140 | 4100 | 326 |
| 150 | 3150 | 289 |
| 160 | 3400 | 2523 |
| 170 | 4300 | 3666 |
| 180 | 4750 | 9211 |

In the equation

$$V_r = V_o e^{-\frac{ar}{m^{1/3}}},$$

where $V_r$ and $V_o$ are velocities in feet per second, m is weight in grains, and r is distance in feet,

a = .033 for standard conditions

Percent Recovery = 87.2

[a]Interpolated values

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